THE ENGINEERING MAGAZINE

THE WORLD IS ITS FIELD

VOL. XXXIX. MAY, 1905. No. 2.

MODERN EXCAVATING MACHINERY FOR THE PANAMA CANAL.

By A. W. Robinson.

II. AVAILABLE TYPES OF SPECIALIZED DREDGING PLANT.

Recent events—particularly the complete reorganization of the Isthmian Canal Commission and the expected formation of an international consulting engineering board—have again brought the Panama Canal into the forefront of interest among all the great constructive enterprises of the world. Mr. Robinson last month reviewed the methods followed in similar huge undertakings preceding. In the present article he gives an admirably clear idea of the machinery now available and best adapted to the several sections of the canal.—THE EDITORS.

HAVING touched in a preceding article upon the methods employed in building some of the great canals of the world and their costs, let us look a little at the types of dredging plant now available and which would be suitable for Panama Canal. With modern appliances of great power and capacity we undoubtedly have a great advantage over earlier works in being able to accomplish more excavation in less time and with less labor. In considering the advantage of these modern appliances, we must always remember that at Panama we have to contend with the disadvantages of climate, remoteness, and high cost of skilled labor. Therefore it is essential that the appliances should be specially designed as far as possible to minimize these disadvantages, the ill-effects of which can be reduced by perfect sanitation, and by making the shovels and dredges as comfortable and easy to operate as possible. The rainy season will undoubtedly make steam-shovel work uncomfortable and slow, but need have little effect on dredge work as the men can be comfortably housed. Remoteness will affect the cost and must be especially pro-

vided for as to strength and durability of all machinery. High cost of skilled labor must be met by adopting methods that will produce large results with a minimum of labor.

Beginning at the sea-harbors at both ends of the Panama Canal, we have several modern types of dredge available. For sandy bottom in exposed sea positions we have the sea-going sand-pump hopper dredge. This is a sea-going vessel which can work in any ordinary weather without anchorage. It passes slowly over the channel, picking up its load of sand, and when full lifts its suction-pipe, proceeds to sea, and dumps its load. Such a dredge may have a hopper capacity of 1,000 to 2,500 cubic yards and can make from 5 to 8 loads per 10 hours, depending on the distance to the point of deposit. It is not adapted for material that will not settle or precipitate in the hoppers.

For harder material in open harbor or channel way, the endless-chain barge-loading dredge is well-adapted. In Europe the endless-chain is the favorite type for all classes of excavation, both wet and dry. On the Suez Canal and the North Sea Canal it was the exclusive type. In view of the development of the single dipper machine, the endless-chain dredge should now be restricted to open channel work, dealing with large volumes of material over wide areas and loading into barges. This type of dredge makes a true and level bottom, is not injuriously affected by tides, currents, or moderate sea, can deal with fairly hard material at a rapid rate, and has greater mechanical efficiency than any other type—that is, it will excavate more cubic yards per horse power. Such a dredge is built in the form of a steel self-propelled vessel and may be designed to dredge 800 to 1,000 cubic yards per hour from a depth of 40 feet economically. It can make a cut 500 feet wide at one time and cover the ground absolutely so that no lumps are left. Such a dredge requires plenty of sea-room for effective work, and its anchor chains require careful watching in situations where they obstruct navigation.

In Europe the endless-chain type is still used for all kinds of work and for dry excavation, but for any other conditions except those stated it cannot compete with the dipper dredge, the steam shovel, and the hydraulic dredge, each for their respective lines of work. No endless-chain dredge can do the variety of work in confined situations that a dipper dredge can do, and no chain excavator such as was used on the North Sea and Manchester Canals, and on the Panama Canal by the French Company, can equal the American type of steam shovel, either in point of power, speed, adaptability, or

economy of labor. The divergence of practice between Europe and America is here well illustrated. In Europe the endless-chain type is developed to its greatest extent. In America the single dipper type, first evolved by the necessity of the small contractor for a light and cheap tool, has been developed until in the modern dipper dredge for sub-aqueous excavation and in the steam shovel for dry work, we have machines better adapted for American conditions than any other.

For general purpose dredging in hard material in more sheltered situations and over confined areas, the dipper type of dredge is well adapted. This type has a single dipper of great strength and power. It is anchored by means of spuds and can either load the material into scows or cast it upon the bank. This type of machine is distinctly American, and has a wide range of adaptability. It has the advantage over the endless-chain dredge of simplicity, of requiring a smaller crew, and of less first cost, although the cost per unit of capacity is about the same. An efficient size of dipper dredge for 40-foot depth is one having a hull about 40 feet wide by 120 feet long, and having a dipper of 6 cubic yards. It can make a load every 40 seconds, or a rate of 540 cubic yards per hour. A dipper dredge of these dimensions working in clay in Boston harbor loads a 1,400-yard scow in 3½ hours and has made as much as 125,000 cubic yards per month. As the performance of this type of dredge depends continually upon the activity and skill of the operator, the levers should be designed to be as convenient as possible and power-operated with little or no manual effort. If a man has to work to push these levers, as in the North, he will do much less work in the enervating climate of the Isthmus. If, on the other hand, he can sit in a comfortable seat and make all the powerful motions respond instantly to the touch of a finger, there is no reason why this type of dredge should not be as active in its movements as in the more bracing climate of the North, where it frequently makes a speed of two dipper loads per minute.

For soft material that must be loaded into barges we have the grapple or clam-shell dredge. This type has reached a high efficiency on the Atlantic Coast and can also be used for picking up blasted rock when fitted with a specially constructed stone grapple.

In several sections of the Canal some rock will be encountered, and the best method of treatment for such deposits will be a matter of special study after the conditions are more fully known. Some kinds of rock can be economically dredged by a powerful dipper or

ladder dredge, and for other kinds blasting is resorted to. For all work of this kind the machinery should be of the strongest possible description and every precaution observed to avoid breakdowns and repairs. Rocky material will be useful in many ways in the construction of the canal, and can be loaded on deck scows, towed to destination, and unloaded by clamshell derricks and deposited where required.

For soft material, sand, or homogenous clay more or less stiff that can be delivered to its destination by pipe-line, we have the hydraulic type of dredge. This type of machine is built in a variety of forms to suit different conditions and it is one of the most recently developed and most valuable types. It places in the hands of the engineer the means to dig and at the same time transport and distribute enormous volumes of clay or soft material at a low cost. Various examples of this and other types of dredging apparatus have been described in previous papers by the writer* so that they are not gone into here. In those papers the great carrying power of pipes of even a moderate diameter was pointed out. Hydraulic dredges are specially adapted to deal with soft material in large quantities and to pump or deliver the material through pipe lines to a distance. This distance may be efficiently as much as 2,000 to 3,000 feet; beyond that great power is absorbed by friction in the pipes.

The percentage of solid matter that can be transported in pipes with water depends on the nature of the material and on the efficiency of the apparatus employed to cut and feed it into the mouth of the suction pipe. Until recently is has been supposed that this type of dredge was adapted to pumping sand only, or very soft material. Now, however, we are able to deal with stiffer materials than heretofore by using powerful cutting or digging apparatus and employing the pump and pipe-line for purposes of transportation to the place of deposit. Clay soils especially lend themselves to this method and can now be worked more efficiently than sand, for the reason that the wear or abrasion of pump and pipes is less and a higher percentage of solid matter can be pumped without precipitation or clogging. Clay, once fed into the suction pipe uniformly and with a proper admixture of water, can be pumped through by a good pump with large passages and sufficient power. The crucial point is in the cutter, which should be of great strength to avoid breakage and special design to suit the material and to avoid clogging.

* See "Modern Machinery for Excavating and Dredging," THE ENGINEERING MAGAZINE, March and April, 1903. Also "Dredges: Their Construction and Performance." International Engineering Congress, St. Louis, 1904.

The great possibilities of this method of transporting spoil may be gathered from the fact that the carrying capacity of a 30-inch pipe, at 15 feet per second and 25 per cent. solid matter, is 2,500 cubic yards per hour, and other percentages in proportion. These dredges can be built efficiently up to capacities of 2,000 to 4,000 cubic yards per hour for pipes that do not have to be handled ashore, and up to 1,500 to 2,000 cubic yards per hour for shore discharge.

For those sections of the Panama Canal which lie in the coastal plains, as from Colon to Bohio on the Atlantic side and from Miraflores to Panama on the Pacific, hydraulic dredges may be used effectively to deal with all the soft material. In these sections of the work it is of the first importance that no manual labor should be necessary on shore, as the banks are covered with tropical vegetation and it would be difficult, if not impossible, to handle large discharge-pipes on shore under such conditions. The first requisite for hydraulic dredging in those sections is to throw up a large embankment on either side to retain the material deposited. Such an embankment may be made by a powerful dipper dredge, making its own channel and casting on the bank. Such a dredge could cut through any obstructions in its way and not a man need step off the dredge. This operation done, we have two small canals and two embankments defining the margin of the great canal, with a core of material in the center. This central core can then be taken out by a great hydraulic dredge with a suspended discharge-pipe long enough to reach over the top of the embankments, from which the material would distribute itself over a wide area by the action of the water. This suspended pipe would be carried by a separate pontoon, which could be at a variable distance from the dredge and permit the deposit of the material in special places. Thus not a man would set foot ashore in either operation, and the dredges would be fitted with comfortable upper decks containing living quarters for the crew, and be especially designed to operate with as little labor as possible. With Texas oil for fuel, and powerful well-designed machinery, the work of running such a dredge would be confined to skilled supervision, manual labor being reduced to a minimum.

How vastly different this from the Suez methods! There, when slaves were not actually engaged in digging with their hands in the broiling sun, the laborious chains of buckets of the dredge lifted up the sand and spouted it on the bank, only for much of it to run back again. The work of the American Contracting Company at Panama, who in the eighties employed chain-bucket dredges with long spouts,

was also of this description; and it is notorious that they got paid several times over for much of the material. The elevator dredge with long spout is obsolete for canal work, and we now have tools of far greater efficiency and capacity, which can be run with smaller crews, and which will put the material where it is required.

At Panama the cost of skilled labor will undoubtedly be high, and the climate is such that great physical effort is impossible. Hence the absolute necessity of adopting the most labor-saving machinery, and of maintaining a large output per man. With a large output per man the burden of high wages disappears. To pay a man $250 per month to run a dredge producing 12,500 cubic yards a day is a tax of only a tenth of a cent a yard; but if the output is small the wage item becomes more serious. To maintain large outputs, it is essential that the very best design and workmanship be used in the construction of the plant and the best management in its operation. Every point that might develop trouble or weakness must be carefully guarded against, and for this experience is a pre-requisite.

Coming now to the high-and-dry section of the canal, the main reliance will be placed on the American type of steam shovel. Seventeen of these machines have already been ordered by the first Commissioners, three of which at this writing are at work and have already demonstrated their ability to reduce materially the cost of excavation in this section. As the work becomes better organized the results will continue to improve. The hard clay of Culebra cannot be more difficult than iron ore of Mesabi, and we find shovels there making a daily average output of 3,000 tons, or equal to say 2,000 cubic yards of clay. Assuming the Culebra cut to contain 45,000,000 cubic yards down to the 50-foot level, and that at Panama a shovel can make only 1,500 cubic yards a day of 24 hours for 200 days a year, this portion could be done by 50 shovels in three years. ($50 \times 1500 \times 200 \times 3 = 45{,}000{,}000$) Several of our great railroads are today doing as much excavating in their improvements of grade-reductions, &c., and nothing is said about it, and a larger volume has been handled by steam shovels in the iron-ore ranges of the North. Hard clay such as exists at Culebra is favorable to steam-shovel work, and this great cut, about the immensity of which so much has been said, has really now become one of the least difficult portions of the work. Should it be decided to make a deep cut to sea level, the volume of excavation will then indeed be colossal—the largest in one place ever undertaken by man; but with our present tools, still further improved in the light of experience, the date and

cost of completion of this deep cut can be fairly, closely and accurately determined.

The Culebra cut was attacked by the old French company with land excavators of the endless-chain type. These machines successfully excavated the North Sea Canal where the material was mainly dry earth and the cost of labor low, but at Panama the results were very different. As pointed out in the previous article, the large crew and expensive track required, together with inability to dig hard materials, are the most serious shortcomings of this machine; and they are inherent in the type, and cannot be remedied by improving the design. It has been thought that a continuous chain of buckets must necessarily have greater capacity than one bucket working intermittently, but this is not so. It is a large chain-bucket excavator which has buckets of ¾-cubic-yard capacity. Such a machine at 13 buckets per minute will have a rate of 9.75 cubic yards per minute. A common size of steam shovel will have a dipper of 3-cubic-yards, will readily work at 3½ dippers (or 10½ cubic yards) per minute, and can occasionaly make as much as 4½ dippers per minute, or 13½ cubic yards per minute. Furthermore, a single powerful dipper of 3-cublic-yards capacity with 60,000-pounds pull applied to it can do far more excavation in hard material than a light bucket of ¾-cubic-yard or a flexible chain carried by a ladder frame.

A greater problem than the actual excavation is the disposal of the spoil, and this item will probably exceed the mere cost of loading the cars by steam shovel. An organized system of tracks is necessary, so that trains of large capacity can be circulated and fed past the shovels as nearly continuously as possible.

The importance of this as affecting the work done by the shovels can hardly be overestimated. The working rate of a 3-yard shovel at 3½ dippers per minute is 10½ cubic yards per minute, or 630 cubic yards per hour. Under working conditions, if one half of this rate is realized it is counted as good work, and it is frequently less than this.

The most effective size of shovel for Panama will be one having a dipper of 2½ or 3 cubic-yards capacity for hard material, and 4 cubic-yards for soft. The shovel should not weigh more than 70 to 75 tons, and should exert a pull upon the dipper of not less than 50,000 pounds. It should have power-operated levers so as to handle with ease, and be as speedy as possible. Larger shovels have been tried, but above 75 tons in weight and 4-cubic-yards capacity of dipper the machine becomes more difficult to handle and slower in

its movements, and more stuff is spilled while loading. A shovel should not be too large for the cars it is to load, in order to do clean work.

In this connection mention may be made of the possibility of using hydraulic transportation for the spoil of Culebra cut. If it should prove possible to lay on a large supply of water at any reasonable cost, the material excavated by the shovels may be carried by pipe line direct from a hopper alongside the shovel and distributed in the lower ground and valleys within reach. The carrying capacity of pipe lines of hydraulic dredges has already been touched upon, and in this case the operation would be aided by gravity. The softer deposits of material may even be washed down by direct hydraulic action of powerful jets similar to hydraulic mining.

As the work advances it will undoubtedly be necessary to design and build special machines to suit the conditions as they arise, and in this way further advances in the art will be made. No plant is in existence today that would be adequate or suitable to Panama conditions. Improvements have followed so rapidly and continuously that machines employed on previous works are obsolete. The improvements are in many cases only of detail; but efficiency of detail governs the efficiency of the whole, and too much attention cannot be paid to details in building dredging machinery. In the item of steam shovels alone, patterns of detail have entirely changed within the last five years, and more changes are now in progress to meet the demand for more power, more speed, and greater efficiency.

In conclusion it may be said that with the modern tools now available great economies may be effected and large volumes of material excavated and disposed of by mechanical means with less manual labor than ever before. Just how much saving can be effected under Panama conditions it is impossible to foretell, and the figures must be determined by experiment. The unquestioned superiority of modern tools will greatly reduce former costs. The high cost of labor and climatic conditions, in that proportion do we increase their efficiency as we can render the modern appliances independent of labor and climatic conditions, in that proportion do we increase their efficiency at Panama.

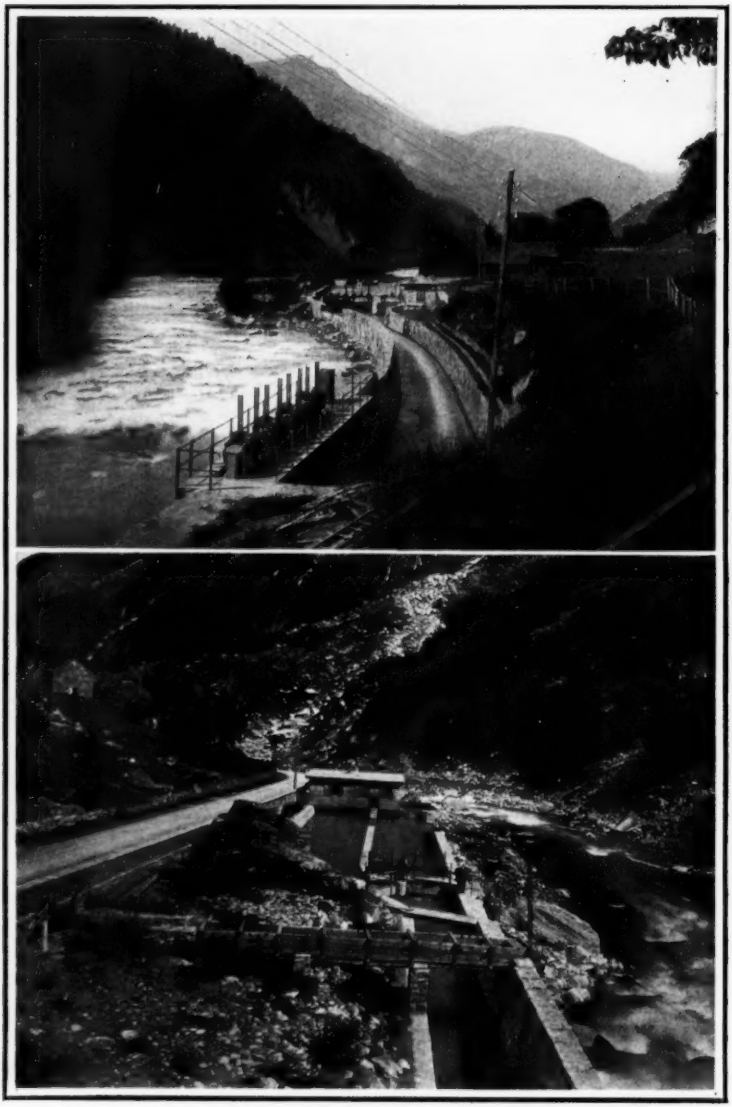
THE CONSTRUCTION OF THE SIMPLON TUNNEL.

By Leon Monete.

On the 24th of February the two portions of the tunnel, which had been worked from either side of the mountain towards the center, came in contact, and at 7.20 A. M. the first drill coming from the Italian side penetrated through the intervening space, thus marking the completion of the great enterprise which had been carried on amid so many difficulties. The Simplon tunnel, with its total length of 12 miles, pierced through the mountain at a depth of nearly 7,000 feet below the surface, is to be ranked among the great engineering achievements of the century, and in its proportions it surpasses anything of the kind which has been previously attempted. Thus the Simplon tunnel is finally run through the mountain, solving the great technical, economic and financial problem which was the object of so much attention for half a century.

AT the beginning of the last century, Napoleon constructed, at an expense of $3,500,000, a route over the Simplon, which led from Brigue, in Switzerland, to Domo d'Ossola, in Italy, and thus seemed to mark out the path for a great international railroad. More than fifty years of study and discussion were necessary, however, before the latter great work could be brought to a successful issue. The first project for a tunnel through the Simplon dates from 1855, but at that time the political conditions were not favorable to its execution. Later on, the Mt. Cenis route was preferred; then came the St. Gothard tunnel, which was carried out by the inspiration and aid of Germany in order to increase the traffic between Germany and Italy. When the Simplon route was finally taken up, the delay had at least one advantage in giving the new tunnel all the recent improvements in underground methods which had developed within late years. In fact, each of the new tunnels was marked by a series of progressive stages in engineering work. Mt. Cenis used mechanical drills, which replaced the old mine chisel and allowed of piercing a 7-mile tunnel, an achievement then without precedent. At St. Gothard, dynamite was substituted for powder, and shortened up the work considerably. In the case of the Simplon tunnel, the progress which had been realized in drilling, owing to the use of hydraulic and electric power, allowed the engineers to attack a 12-mile tunnel without hesitating, and this is the longest which has yet been constructed.

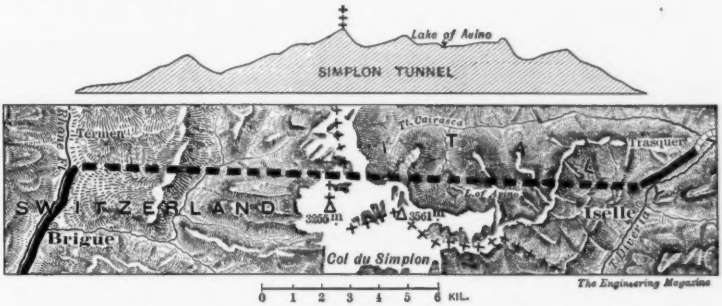
There were no less than twelve projects for the work of the tunnel, and these can be divided into three general classes—low,



HYDRAULIC CANALS AT THE OPPOSITE ENDS OF THE TUNNEL.

That shown above is the one drawing water from the Rhône, on the Swiss side; the one in the lower picture is on the river Diveria, on the Italian side.
The hydraulic power was used in driving the tunnel.

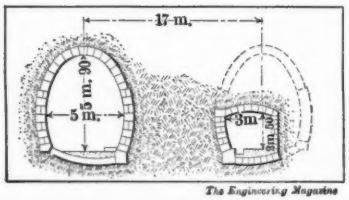
medium and high tunnel, according to the altitude. The base or low system was finally adopted; although it makes a longer tunnel, it is easier to connect with the railroad at either side, without using too heavy grades. The construction of such a tunnel offered special difficulties which could not have been overcome twenty-five years ago, and the engineers were obliged to take many precautions in carrying out the work, especially as regards hygiene and ventilation. The mountain is 1.2 miles high above the tunnel in some places, and at such a great depth the heat becomes excessive. The workmen had to support a temperature of 95 to 104 degrees F., while it was only 84 degrees at Mt. Cenis and 86 at St. Gothard. Special powerful air fans had to be used, and water sprays were employed to cool the inside of the tunnel.



MAP SHOWING THE LINE OF THE SIMPLON TUNNEL.

The mass of the Simplon, which separates the Rhone basin from that of the Loce, in Italy, forms a high rampart between Switzerland and Italy, with several summits of considerable altitude, such as the Monte Leone (11,600 feet), the Wasenhorn (10,580 feet), and the Furggenbaumhorn (9,720 feet). The railroad which is to pass through the mountain starts from the station of Brigue, which is the present terminus of the Swiss railroad, passing along the shore of Lake Leman, mounts 1½ miles along the left bank of the Rhone, and curves to the right, entering the tunnel. The latter is directed from northeast to southwest, and measures 19,803 meters (64,960 feet) in length. It comes out on the Italian side near Iselle. a small place on the Diveria River, and 9 miles from the Italian railroad terminus at Domo d'Ossola. Here the Simplon railroad will join the Italian line which passes to Milan.

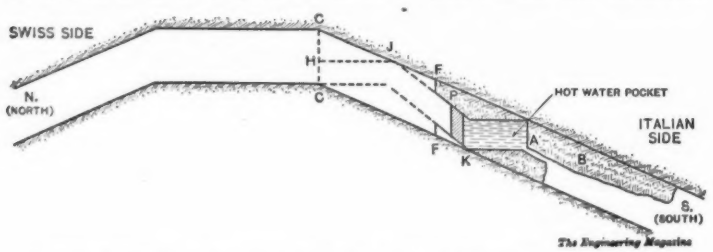
From the entrance of the tunnel the track rises slightly each way to the middle (0.7 per cent.), so as to drain off the water. The



SECTIONS OF MAIN AND SECOND TUNNELS.

The dotted lines in the right-hand figure represent the eventual enlargement. The small tunnel now serves to ventilate (by cross-cuts) the main one.

Italian-Swiss frontier is crossed at 5.5 miles from the north end, and it is also at this point that the mountain has its greatest height. What distinguishes the Simplon from the other great tunnels is that instead of using a double-track tunnel, it is laid out to form two single-track tunnels lying parallel and at 55 feet distance between the centers. This solution has the advantage of allowing the construction of the second to be postponed until the increase of traffic makes it necessary, but it also offers a convenient and economical method of building the first tunnel and gives a good ventilation. The work was begun by piercing the two advance headings of each tunnel, and these were connected by short cross-galleries at every 600 feet. Only one of the tunnels is enlarged to the final dimensions—19.5 feet high and 10 feet wide. This forms the single-track tunnel No. 1, while the other drift, which is to be tunnel No. 2 in the future, now serves as a ventilating gallery for the first. During the work, the second gallery was used to a great advantage for ventilating, draining off the water, and transporting the materials. Here were placed the high-pressure water pipes for the drills and for washing down the débris after each explosion. The trains which pass through the tunnel on single track are to cross in the center, and here the project carries the design of an underground station some 1,600 feet long, where the two tunnels will be joined in one. The station will somewhat



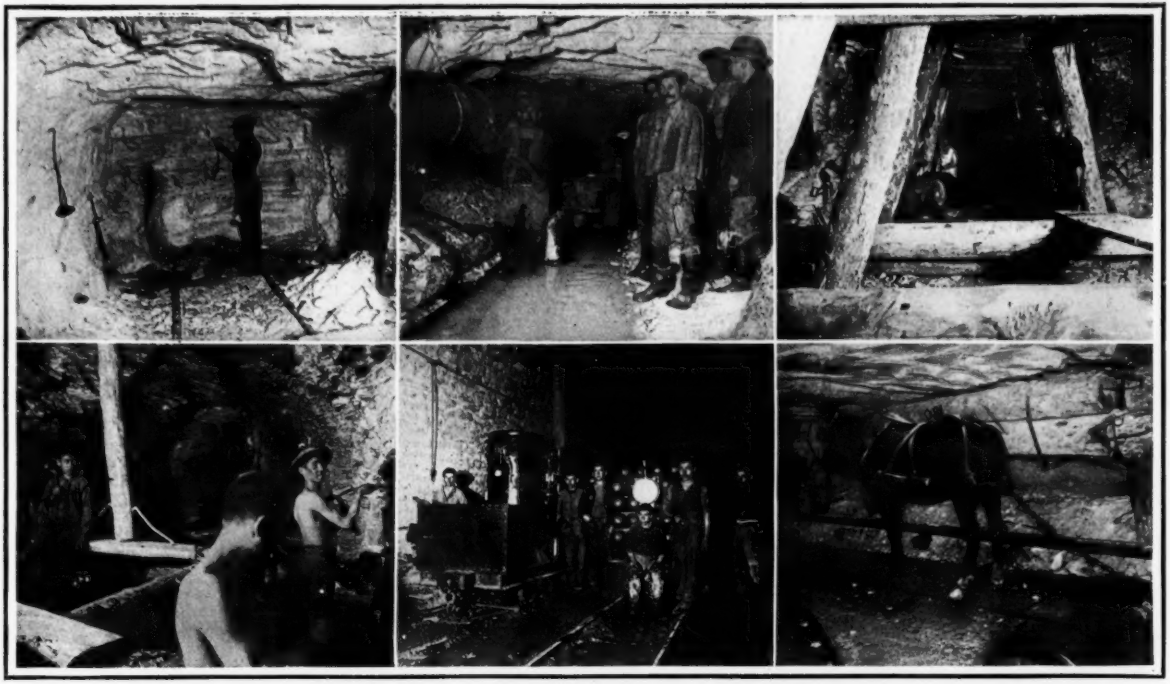
SECTION SHOWING THE MEANS USED FOR CONFINING AND CONTROLLING THE HOT-WATER FLOW.

FF, temporary end of workings from Swiss side; P, iron door confining the hot water which first flooded the workings; A, entrance made by the drills, working from the Italian side.

resemble a subway station, with the difference that the passengers have a thickness of 1.6 miles overhead. The ventilation of the tunnel was carried out during the work by large air fans of 500 horse power each. These could deliver as high as 130 cubic yards of air per second to the working points, and were always in operation. Hydraulic power was the main source of energy for the Simplon tunnel. It operated the drills, aided in taking off the residues, cooled the working face, and also produced electricity. The water was brought to the outer ends of the tunnel by long canals in reinforced concrete, one from the Rhone and the other from the Diveria.

REINFORCED CONCRETE FLUME CARRYING THE HYDRAULIC CANAL FROM THE RHÔNE.

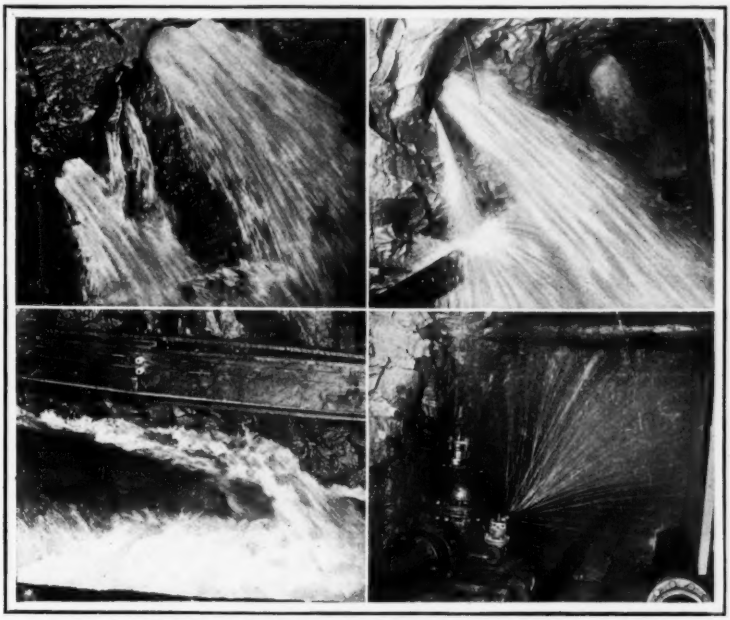
The drilling of the tunnel was commenced on August 1, 1898, and according to the rate of advancement it was supposed that the work would be finished about May 1, 1904; but considerable delay came from the springs of hot water which were met with unexpectedly in several places and flooded the tunnel at various times. It was the great abundance of water, more than the high temperature of the tunnel, which caused the most difficulty throughout the work. The Simplon, like the other great tunnels, has a sloping profile, with the highest point in the center and a slight grade on either side towards the mouth. This allows the water to be easily drained off in ordinary cases. If the headings had been advanced with the same rapidity on both sides of the tunnel the two working points would have met in a point at the middle of the tunnel or about the highest altitude. This was not the case, however. The Swiss side advanced more rapidly at first, as the flow of water was less than on the Italian side, being 10 gallons per second against 200 gallons. The Swiss



UNDERGROUND WORK IN THE CONSTRUCTION OF THE SIMPLON TUNNEL.

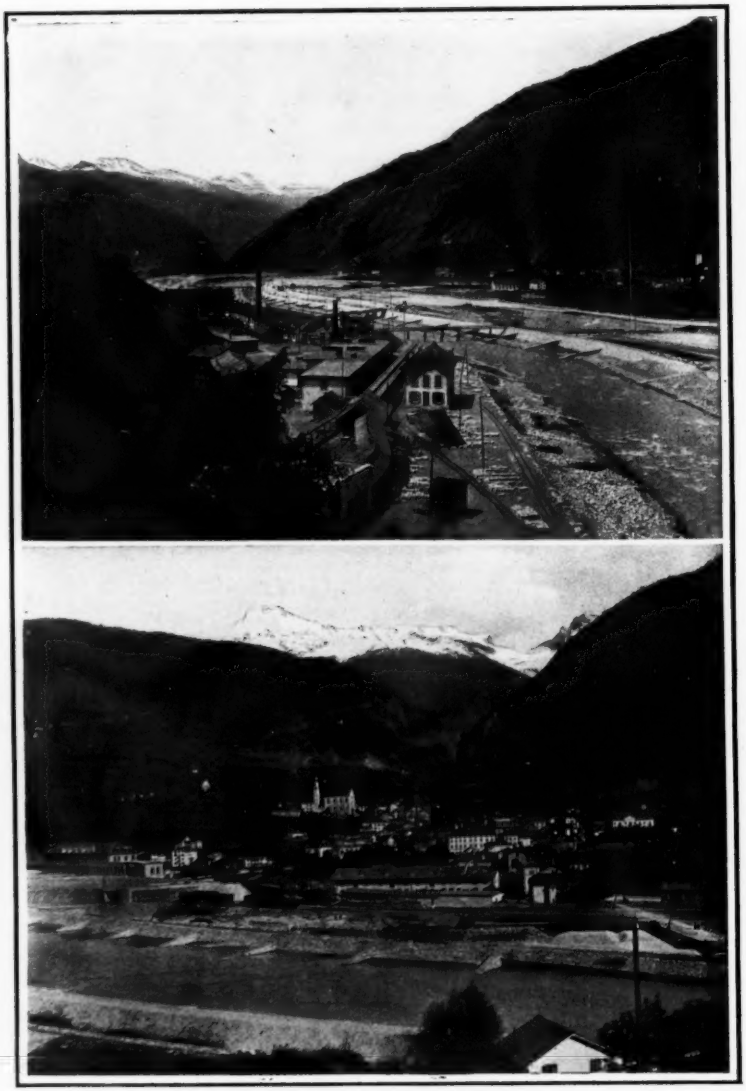
From left to right, the views show:—In the upper tier, 1, preparing to fire the shots; 2, the first heading; air conduit on the left; 3, in the heading. In the lower tier:—4, enlarging the section; 5, compressed air locomotive and reheater; 6, horse haulage in a cross-cut.

side thus passed the middle point in the early part of 1904, and then commenced to descend the southern slope of the tunnel. But during the work a very heavy outflow of water was encountered which obliged them to suspend operations altogether on that side. As the water could not be drained off, it was decided to confine it at least



SOME SUGGESTIONS OF THE WATER PROBLEMS OF THE TUNNEL WORK.
The two pictures in the upper tier are springs encountered at kilometre 4.442 and 4.436 respectively. On the left below is shown the water flowing into the drainage channel. The lower right-hand figure is a cold-water spray for reducing the air temperature.

to the end of the tunnel, and a heavy iron door was mounted across the tunnel about 800 feet from the end. This formed a reservoir or pocket containing some 4,000,000 gallons of hot water at a temperature of 120 degrees F. The drills on the Italian side kept gradually approaching the front end of the pocket, and the sounds of the work could be heard from either side. For the last few days the drills advanced with great precaution. Then came the moment when one of the drills bored through the last space in front of the reservoir and the water commenced to filter through. When the drill was withdrawn a jet of water followed it, and the long-expected moment arrived when the tunnel was completely pierced. Afterwards the



BRIGUE, AT THE SWISS END OF THE TUNNEL.

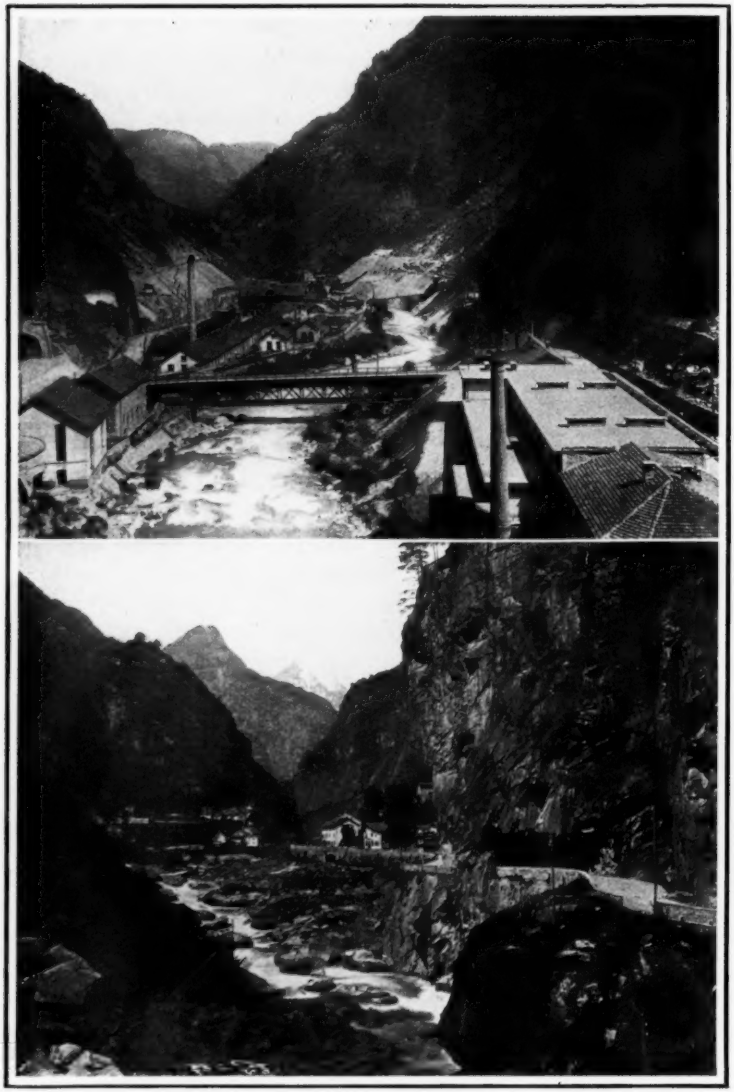
The lower view shows the village, and the upper one the shops, store houses, and installation in general for the tunnel work.

opening was enlarged and the water drained off by piping, which had already been prepared for this event. It took only a few hours to drain off the reservoir, and now the work is being continued until the tunnel will have its standard size clear up to the end of the Swiss side, which had been abandoned. It then will remain to complete the masonry of the tunnel, and afterwards to lay the track for the electric trains, which are to be used here. This will take several months, and it is expected that the inaugural opening of the tunnel will come during the fall. This makes nearly seven years from the starting of the tunnel until the moment when the trains will be running from Brigue to Domo d'Ossola, and the work will have cost something like $16,000,000.

The installations at the ends of the tunnel at Brigue and Iselle, which will be observed in the engravings, give an idea of the extent of the work. At each end, the offices and shops cover an area of 7,000 square yards, including engineers' offices, engine and turbine plants, dynamos, forges, repair shops, locomotive houses, stables for the horses, storehouses of all kinds, for lime, cement, iron, dynamite, and the observatories for the surveying of the tunnel. At the two ends veritable villages were built to accommodate the thousands of workmen employed in the tunnel and shops. Two turbine plants were erected, on the Rhone for the north side, and on the Diveria for the south, to obtain the 2,400 horse power which was needed for the drills, the lighting, and the twenty-five trains per day for workmen and materials. To ventilate the tunnel and lower the rock temperature, which sometimes reached 132 degrees F., a system of powerful fans sent from 50 to 60 million cubic feet of cold air to the end of the tunnel per 24 hours.

During the five years of work in the tunnel, the operations were carried on continuously day and night without stopping except to verify the alignment of the tunnel. The gangs of workmen took eight-hour turns, and in the more difficult places this was reduced to six hours. When the attack advanced at the same time in the two galleries and in a good rock, the rate of working was from 15 to 30 feet per 24 hours, or some 6 feet for each explosion of dynamite, in a gallery 6 feet high and 10 feet wide. The consumption of dynamite reached half-a-ton per day.

The main difficulties on the Italian side lay in the hardness of the rock in some places, and again in a soft and yielding rock which threatened to crush all the vaulting that could be constructed. The action of the drills upon the granite of the region had been observed

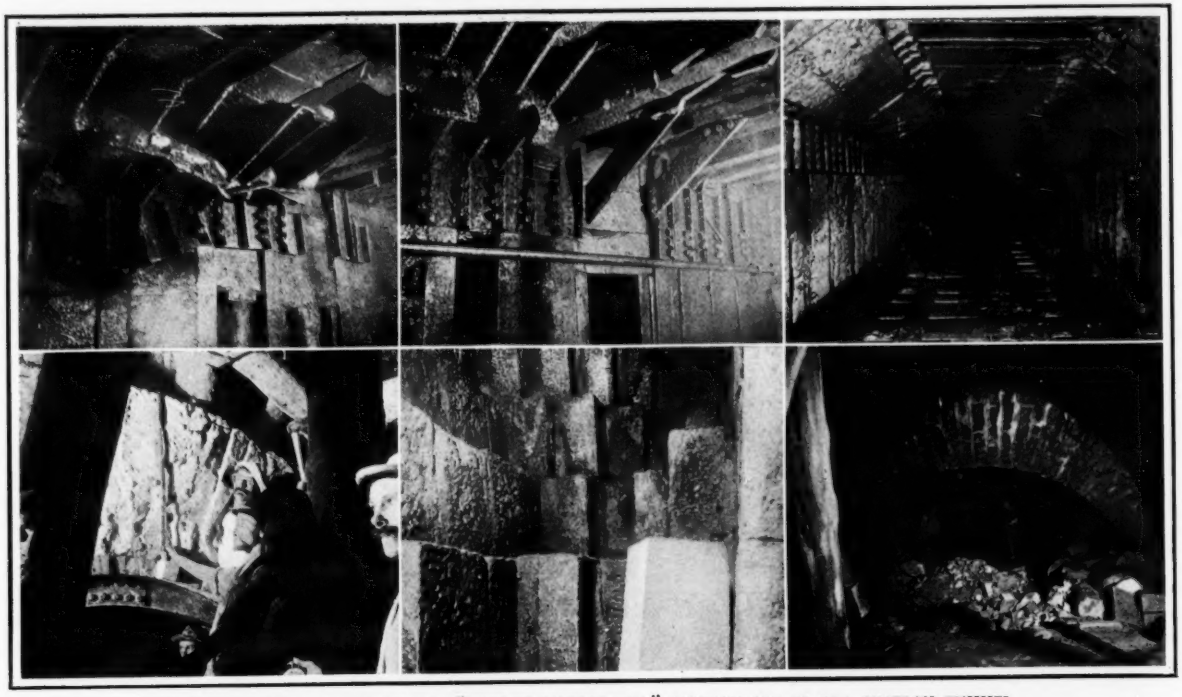


ISELLE, AT THE ITALIAN PORTAL OF THE TUNNEL.

The lower picture shows the village; the upper, the tunnel installation. The railway formerly terminated at Domo d'Ossola, but was extended up to Iselle to complete the tunnel route.

in the open air and upon blocks taken from the mountain and submitted only to atmospheric pressure. But when the drills met with the granite under much greater pressure, due to the layers of the mountain overhead, they could not attack the rock which had thus been made more compact except by using a higher hydraulic pressure and a longer working period. The enlargement of the tunnel section by the pick also suffered a like delay owing to the hardness of the rock. This will be noted when it is stated that during the whole of the passage through the granite, the shops were obliged to re-forge and re-temper as many as 13,000 mine chisels per 24 hours. As the gallery is formed, the walls are freed from the counter-pressure of the interior. This brings about an extraordinary effect. Under the concentric pressure the rock splits off with a deafening noise and the debris is shot for several yards. A workman was killed by being struck with one of these flying pieces. This very strange phenomenon caused much fright and perplexity at first, and it took some time to become accustomed to it.

After passing the granite the workmen came upon a region of bad rock which caused even greater difficulties. In the first place, after going through the solid rock, they met with a hot spring of 90 degrees F. at the 2.4 mile point. Then at the 2.6 mile point they found cold springs. The work had to be stopped until the water could be taken off by a system of piping. Then they proceeded cautiously and by hand, and soon reached a point which gave them a great deal of trouble. On November 5, 1901, at the 2.8 mile point, the drills penetrated into a rock which was found to be very soft, and this event was unforeseen. Solid timbering was built to uphold the roof, as usual, and the work proceeded. But before 50 feet had been passed, it was found that the rock was sinking, and it caused an almost irresistible pressure upon the timbers, distorting them and threatening to break them in fragments. Fortunately this action was slow, but some measure had to be taken at once. To resist the pressure, a series of heavy frames built of 16-inch channel bars, capable of supporting 100,000 tons, were set up and reinforced by heavy beams. The frames, spaced 6 feet apart, served to uphold the roof, and 74 of them were used here. Even this construction was not strong enough, and it had to be reinforced by new pieces. The iron was bent and twisted under the pressure of the mountain. This new framework, however, was only temporary. It formed an armored passage through which passed all the material needed for the advancement of 2 miles of tunnel in the space of two years, without

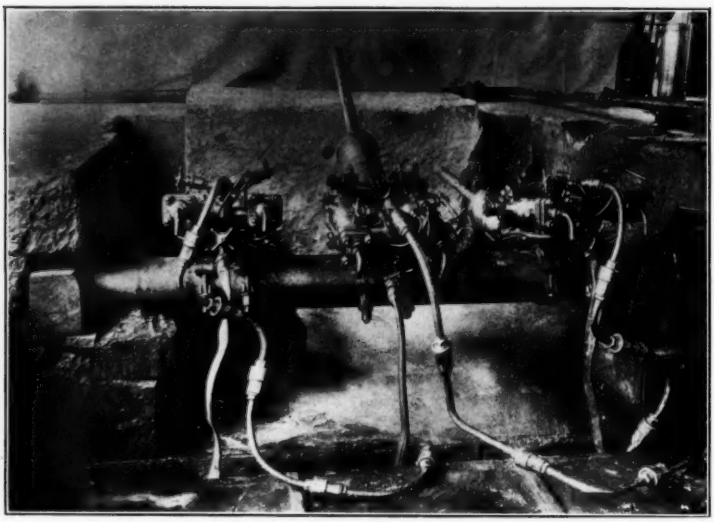


FEATURES OF THE WORK IN THE "ZONE OF COMPRESSION" ENCOUNTERED IN THE SIMPLON TUNNEL.

Reading from left to right, the small illustrations show:—In the top row, 1, the effect of the rock pressure on the tunnel lining; 2, the heavy steel lining first put in; 3, lining consisting of iron frames with concrete filling; cold water conduit on the left. In the lower row; 4, first heading for the permanent lining; 5, keying of the permanent arch (looking upward); 6, masonry centering of the permanent arch.

interruption, including six trains of workmen per 24 hours, trains of debris, wood, tools, masonry and cement. But this roofing had to be replaced by a permanent construction having the standard section of the tunnel. This took 18 months and required an extraordinary work. It was carried out as follows:—

In the narrow intervals between the frames, the workmen made a series of lateral niches, on one side only, which were just large enough to stand in. Then with great difficulty they dug beneath their feet a series of pits about 10 feet deep. For every cubic foot taken out they had to brace the sides very strongly with beams and plates, to resist the pressure of the mountain. From the bottom of these pits, using the same precaution, the miners arrived under the frames and dug out spaces 8 feet long and 2 feet wide, or in the direction of the tunnel. After this work had been carried out inch by inch, one may say, the miners gave place to the masons who were chosen among the most expert. In the chambers which were thus formed they built a foundation of well-cut stone and cement, which filled up the space. This made a continuous foundation floor for the tunnel, as a similar work had been carried out meanwhile from the other side, and the remaining spaces were filled up by masonry. The foundation was perfectly homogeneous and solid. It then remained to build the side walls and the vaulting, but this could not be done at once, on account of the enormous pressures. They decided to surround the armored vault by masonry covering which should be temporary and give a support for the permanent vaulting. This was done by building up very solid pillars in the niches already mentioned and upon them was placed an arch in channel iron resting on the tops of the pillars. Above the arches was laid a masonry vaulting formed of granite and first quality of cement. These pillars and arches, having some 3 feet width, were separated by 2½ foot spaces, but a set of beams connected them across. Thus the 140 feet of gallery at this point was upheld by 25 solid arches. The iron frames, which had arrived at the limit of resistance and were bent and twisted, were removed. In some places they had left but an inch above the traveling carts. It then remained to build the permanent uprights and vaulting. The side wall was built in sections which were then joined together, and is more than 10 feet in thickness. For the vaulting, they superposed four ranges of concentric voussoirs, the inner of which rested upon the temporary vaulting. The space between the outer arch and the rock was filled up with cemented masonry. The inner and temporary vaulting was then removed by dynamite. At present the base,



BRANDT DRILLING MACHINES, USED IN DRIVING THE TUNNEL.

the wall, and vaulting form a solid canal, which is able to resist the immense pressure exerted upon it from all sides. In fact, it has shown no movement, and this work, although it is buried in the depths of the earth, is one of the most admirable examples of the engineer's art. The figures will give an idea of this undertaking, when we find that it cost $5,000 per running yard, and this with European labor. Few of the passengers who travel through the tunnel will think of the work which was required to retain the pressure of the mountain at this point.

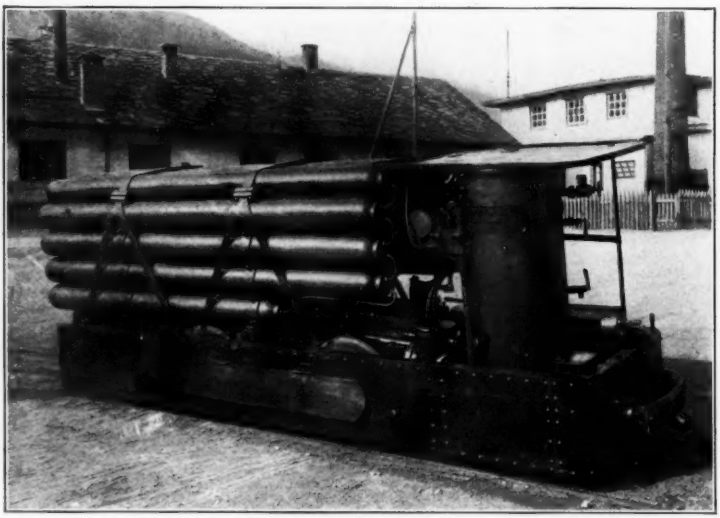
On September 6 of last year the drills opened a spring of 20 gallons per second at the 5.5 mile point of the tunnel on the Italian side. The water had a temperature of 111 degrees F., and the work had to be abandoned at once. As the rock had been very dry up to this point, nothing indicated that they would receive such a shower-bath. The water flowed along the tunnel for some 2,000 feet, where it found a passage into the side gallery and ran into a sewer which led from there. The first thing was to continue the sewer in haste as far as the source of the spring and thus take off the water by the side gallery, clearing the main tunnel. This canal was entirely covered to keep in the heat and allow the men to work. The next operation was to push the side gallery, since they could not go ahead with the tunnel. They would finally reach the spring from here also, but in

this case they were prepared to take off the water in wood conduits to prevent heating. As soon as it appeared, the water was easily led off by the conduit. When the critical point was passed by the advance of the gallery, they cut through to the axis of the main tunnel by a cross passage, and were now 100 feet ahead of the end of the tunnel. From here they went on with the main tunnel to the north, and at the same time turned back to the south and took down the short piece of 100 feet in the rear so as to reach the main tunnel. This last operation was carried out in December and January last.

The work of installation commenced on August 6, 1898, at Iselle, and on August 16 at Brigue. The mechanical drilling commenced on the north side November 22 and on the south end one month later.

As to the main railroad lines which connect the Simplon route, it may be mentioned that the Italian Government, which controls the railroads on that side, has neglected nothing to secure a good connection for through trains coming from the north, and has laid out 15 millions already for this purpose. The Simplon is connected with Milan by the Arona-Domo d'Ossola branch, and with Turin by the Borgomanero line. On the northern side France has done nothing as yet to further the international through traffic. This is owing to

AIR-COMPRESSOR INSTALLATION FOR THE TUNNEL, BRIGUE.



A COMPRESSED-AIR LOCOMOTIVE USED IN THE SIMPLON TUNNEL WORK.

the fact that a number of different projects have been proposed, and these have conflicting interests, so that after considerable discussion, nothing definite has been decided upon as yet.

At present the distance between Calais and Milan is 1,147 kilometers (712 miles). It will be 1,131 kilometers (703 miles) by the Simplon route. The distance from Paris to Milan, which is 893 kilometers (556 miles) by the St. Gothard route, will be shortened to 833 kilometers (517 miles), using the proposed Mont d'Or straight cut in France. The rapid express trains will run from Lausanne to Milan in 5½ hours, and from Paris to Lausanne in 9 hours, when the La Joux-Vallorbe line is constructed. However, the railroad lines which now exist between France and the Simplon are not adapted for rapid international traffic over the whole distance.

TABLE OF COMPARATIVE DATA OF SEVERAL GREAT TUNNELS.

	Mt. Cenis.	St. Gothard.	Arlberg.	Simplon.
Length of the tunnel.....	7.9 miles	9.25 miles	6.38 miles	11.9 miles
Maximum altitude	4219 feet	3755 feet	3260 feet	2290 feet
Heaviest grade, per cent.....	2.2	2.7	1.5	0.7
Height of the mountain above the tunnel	5390 feet	5544 feet	2340 feet	6840 feet
Maximum temperature, degrees F.	84 deg.	86 deg.	64½ deg.	104 deg.
Mean daily rate of advancement..	5.1 feet	9.7 feet	15.7 feet	16-18 feet
Duration of the work.....	13 years	9 years	4 years	7 years
Cost per running yard.....	$1075	$700	$625	$770

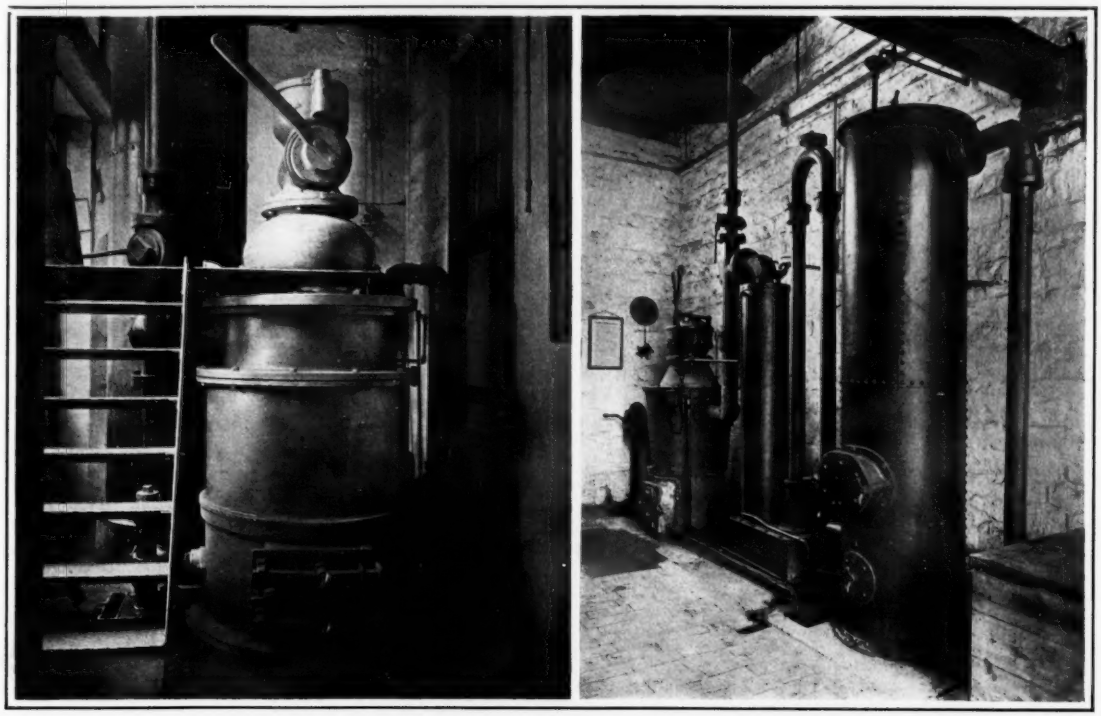
THE DESIGN AND OPERATION OF THE SUCTION GAS PRODUCER.

By Rodolphe Mathot.

While much attention has been directed of late to the development of the large gas engine, there has at the same time been in progress an important advance in the design and operation of moderate-sized gas-power plants. By the rapid introduction of the suction gas producer, operated in connection with the ordinary gas engine, it has been made possible to generate power in small units at a cost hitherto attainable only with the largest and most complete power stations. Mr. Mathot is recognized as one of the ablest experts on the Continent in the special department of the design of gas-power plants, and in this paper he gives the results of the latest experience as it affects the proportions and operation of such plants; to which a brief description of the general arrangement of a suction plant has been prefixed. In a succeeding article Mr. Mathot will discuss the principal features in the latest improved gas engines which aid in enabling the suction plant to compete successfully with the highest types of steam engines.—The Editors.

THE early gas engines were designed for the use of illuminating gas, but the high cost of this fuel has led to the design of various forms of apparatus for the production of a cheaper fuel. Among these the best success has been had with various forms of gas producers, supplying what has been generally termed "producer" gas, of which the combustible portion consists mainly of carbon monoxide. In general, such producers consist of a generator, usually cylindrical in form, and of sufficient height to contain a deep bed of fuel. The lower portion of the fuel bed, resting on a grate, is raised to incandescence by a blast of air supplied either by a fan or by a steam jet, the result being a combustion of a portion of the coal to carbon dioxide, and this passing through the upper portion the heated coal becomes largely converted into carbon monoxide. Any steam which is delivered below the grate becomes dissociated in passing through the incandescent coal bed, the hydrogen enriching the gas, and the oxygen combining with the carbon to form carbon dioxide, afterwards partly converted into carbon monoxide, the final product being what is termed semi-water-gas.

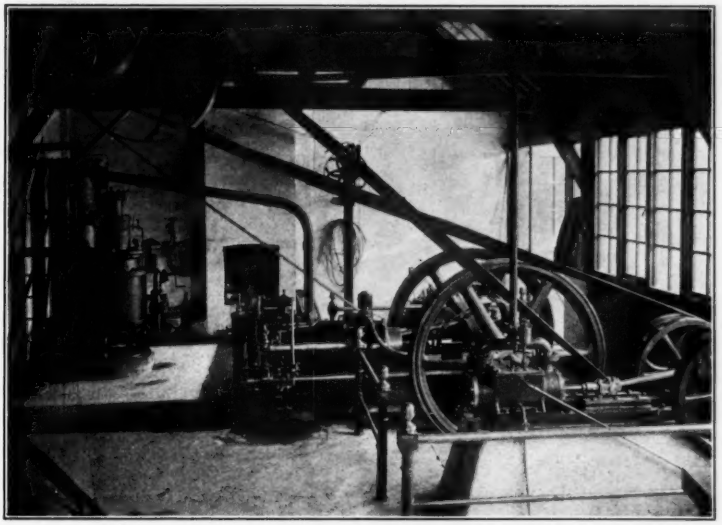
The principal practical difficulties which have been encountered in using producers of this type have been of a mechanical character. A separate steam boiler is necessary to operate the steam jet, and the fact that there is a pressure beneath the grate makes it necessary to have some form of water seal, or tight joint at the bottom, while



TYPES OF SUCTION PRODUCER APPARATUS IN ACTUAL INSTALLATION.

On the left is a 60-horse-power Otto suction producer. On the right, a 25-horse-power Dowson suction plant and National gas engine at Althorp Park, the residence of Earl Spencer. It is used for electric lighting.

the entire apparatus also has to be made gas tight. Since the production of gas is independent of the operation of the gas engine to which it is supplied, it is necessary also to provide a gas holder, to act as a storage reservoir, so that the whole plant is more or less cumbersome and requires a certain amount of skilled attention.



GAS ENGINE AND SUCTION PRODUCER DRIVING STONE-DRESSING MACHINERY.
Generator 74 in. high over all; scrubber, 85 in.; engine, 35 indicated horse-power, 180 revolutions. Installed by Tangyes, Ltd., Birmingham.

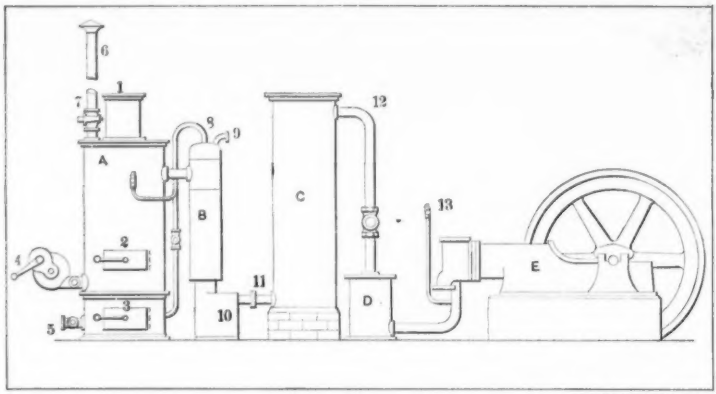
In the modern internal-combustion engine, whether of the four-cycle or the two-cycle type, one of the outward strokes in the cycle is a suction stroke, and this suction is always employed to draw in the mixed charge of gas and air. Instead of allowing this suction to draw the gas merely from a holder or main, it has been suggested to connect the engine directly to the upper part of the producer, and thus utilize the suction of the engine to draw the air through the coal bed, instead of impelling it by pressure. This is the fundamental idea of the suction gas producer, a device which bids fair to extend the use of the complete gas-power plant to a much wider field than has hitherto been possible.

Apart from the dispensing with the separate blowing jet, the substitution of suction for pressure causes a pressure slightly below that of the atmosphere to be maintained in the whole apparatus, so that there can be no leaks of gas, and there is no necessity of sealing

the ash pit. As no steam under pressure is required, the separately-fired boiler is replaced by what is termed a vaporizer, this consisting of a vessel containing water, raised by the heat of the gas to a temperature nearly as high as the boiling point, the vapor thus formed being delivered under the grate and drawn through the coal bed, with the air, by the suction of the engine. Since the rate of the production of the gas depends upon the suction action of the engine, the supply is automatically controlled by the demand, the production of gas ceasing when the engine is stopped, and increasing if the speed of the engine is increased. There is therefore no necessity for a gas holder, and no gas is stored at any time beyond that which is contained in the pipes and passages of the apparatus.

It will be seen that the substitution of suction for pressure has thus simplified the apparatus by dispensing with the steam boiler, and with the gas holder, and has also done away with the operative difficulties involved in a sealed ash pit, while at the same time it introduces the advantages of an automatic regulation without the employment of a single piece of additional apparatus.

The general construction of a suction-producer plant will be obtained from the following illustration:—

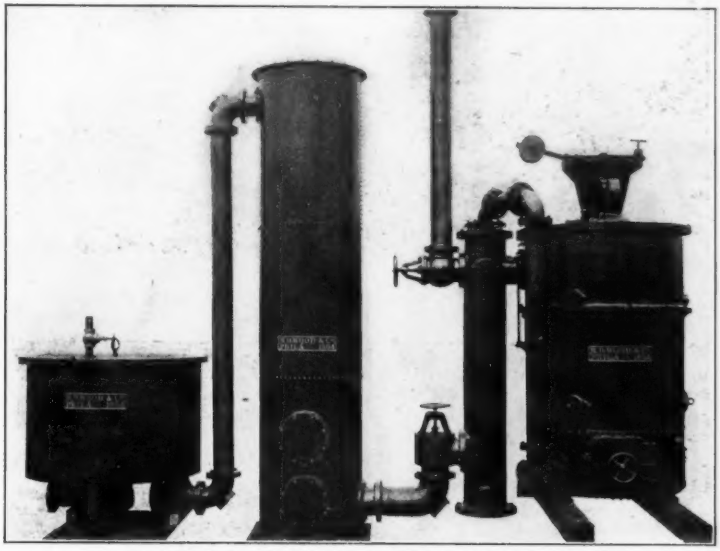


The Engineering Magazine

GENERAL ARRANGEMENT OF A SUCTION PRODUCER PLANT.

A, producer; B, evaporator; C, scrubber; D, pressure equalizer; E, gas engine. 1, coal hopper with gas lock; 2, cleaning door; 3, ash-pit door; 4, hand blower, for starting; 5, air valve; 6, escape pipe; 7, outlet valve—these for use when the gas engine is not running. 8, pipe conveying steam from vaporizer to ash pit; 9, air inlet to vaporizer; 10, water box; 11, gas connection to scrubber; 12, gas outlet from scrubber; 13, test valve for sampling gas at engine.

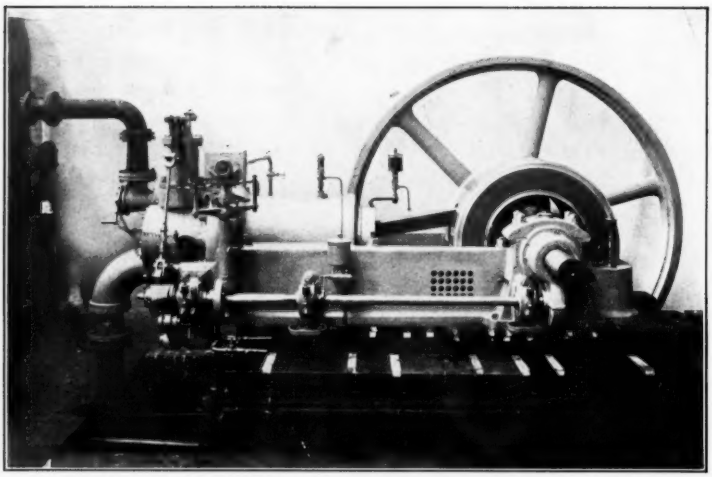
The introduction of the suction producer appears to have given a fresh impetus to the development of internal-combustion motors operating with lean gas. It will therefore be of interest to consider the desirable features involved in the design of these gas-producers and the motors to be used with them, in order to secure a satisfactory and regular operation.



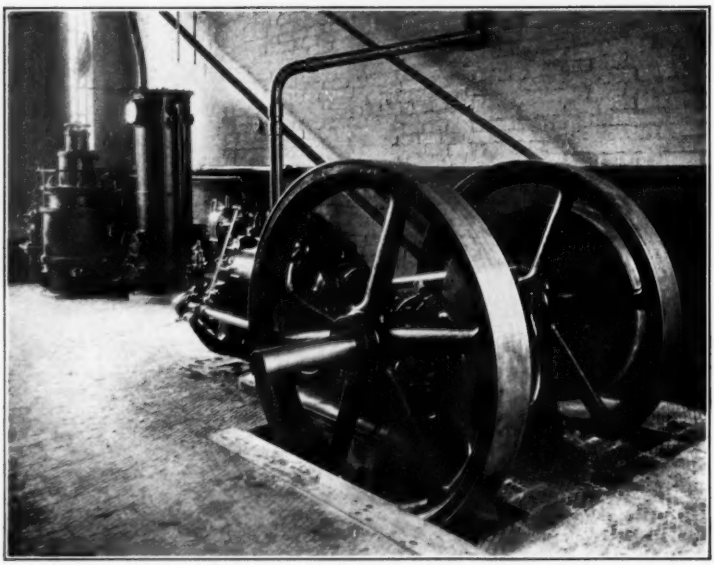
SEVENTY-FIVE HORSE-POWER SUCTION-PRODUCER PLANT.
R. D. Wood & Co., Phila., Pa.

So far as the gas producer itself is concerned, it is now four or five years since the principle of utilizing the suction produced by the engine as an effective substitute for the blast of a jet or fan blower has been successfully applied in working apparatus. Although the subject is therefore still a novelty, certain principles have already developed, from practice rather than from theory, by means of which the best results may be obtained in the use of suction devices for generating lean gas.

At first the designers of such apparatus, probably guided by the experience obtained in steam-boiler practice, tended to construct producers of too large dimensions, especially in regard to the dimensions of the retort, or producer proper. The result of this practice was the production of an abundant volume of gas, but of a very poor quality because the temperature of combustion was kept too low.

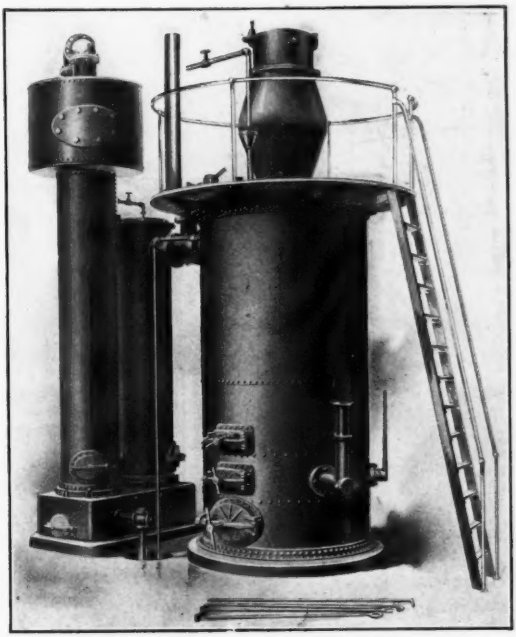


SIXTY-HORSE-POWER OTTO SUCTION GAS PRODUCER AND GAS ENGINE.
Gas Motoren Fabrik Deutz.



A SUCTION PRODUCER AND GAS ENGINE FOR DRIVING MACHINE TOOLS.
Over-all height of generator, 74 in.; of scrubber, 97 in.; engine, 47 indicated and 39 effective horse-power, 180 revolutions. Supplied to Swift Cycle Co., Coventry, by Tangyes, Ltd., Birmingham.

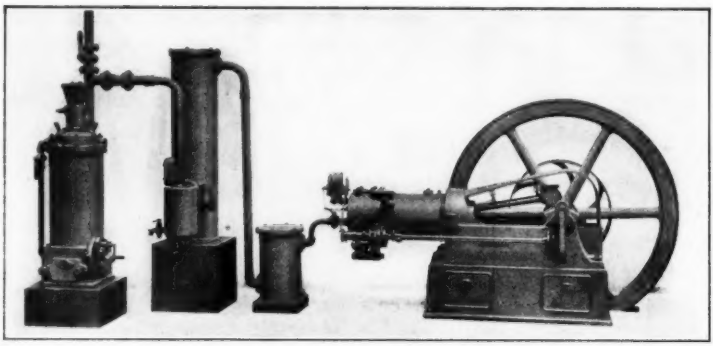
The fact must always be borne in mind that the principal element which enriches the gas is the hydrogen resulting from the dissociation of the water, contained in the state of vapor in the air by which the furnace is fed. The draft, or supply of air, induced by the motor, is a function of the dimensions of the machine, while the velocity of the air current becomes greater as the area of the grate is reduced. It is this velocity of the air which augments the activity of the fire, and renders possible the dissociation of the maximum quantity of water.



AMERICAN CROSSLEY SUCTION GAS PRODUCER.
Built by the Power & Mining Machinery Co.

Experience has demonstrated that the cross section of the base of the producer which gives the greatest production of hydrogen and the most effective reduction of carbon dioxide to carbon monoxide, varies between 0.6 and 0.9 times the area of the piston of the engine producing the suction. This rule applies to the simple four-cycle gas engine, running at a linear piston speed of 600 to 800 feet per minute. The depth of combustible contained in the upper part of the producer retort should be from two to five times the diameter of the base, for lean coals in sizes from ½- to ¾-inch lumps.

The above proportions, when the apparatus is properly arranged and fed, have been shown in practice to be well adapted to provide a combustion zone and a reduction zone of the proper thicknesses to transform continuously the maximum proportion of vapor of water

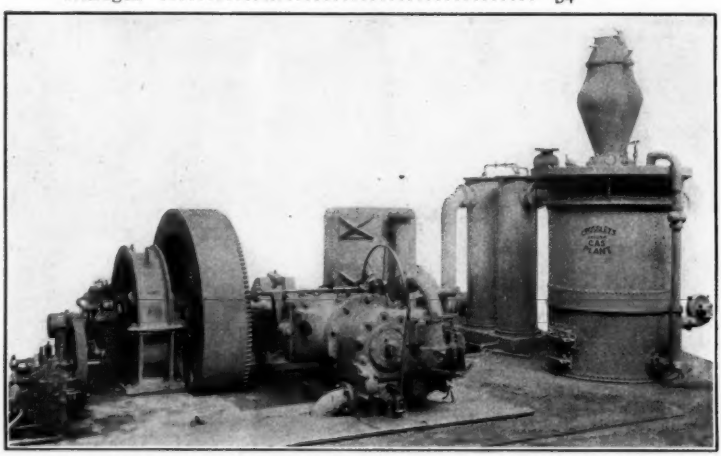


A 12-HORSE-POWER SUCTION-GAS-PRODUCER INSTALLATION.
Maschinen fabrik Kappel, Chemnitz-Kappel.

and to reduce the corresponding proportion of carbon dioxide. The quantity of water dissociated varies from 0.8 to 1.2 times the weight of lean coal consumed.

An examination of more than a score of chemical analyses of the gas produced by various systems of suction gas-producers gives the following average composition:—

Carbon monoxide	24	per cent.
Carbon dioxide	5	" "
Hydrogen	17	" "
Nitrogen	54	" "



EIGHTY-HORSE-POWER GAS ENGINE AND SUCTION GAS PRODUCER, FOR CALCUTTA ELECTRIC SUPPLY CORPORATION.
Fuel consumption 0.92 lb. coke per brake-horse-power hour. Crossley Bros., Ltd., Openshaw, Manchester.

Methane appeared in traces only, since these installations were operated with anthracite coal. The calorific power of the gas ranged from 135 to 150 British thermal units per cubic foot, varying according to the composition of the fuel, the average constitution of the coal being:—

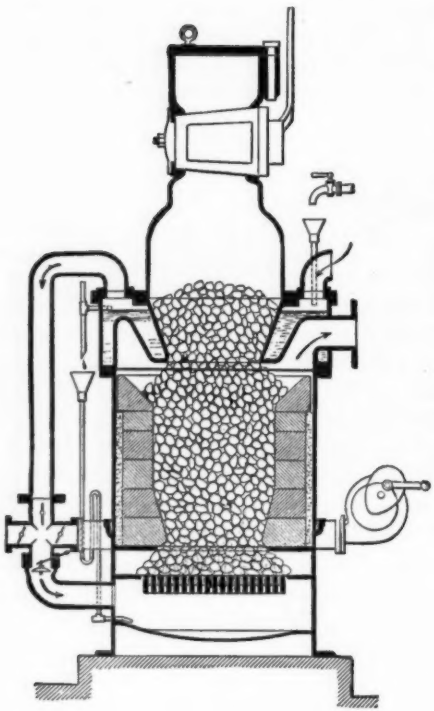
Carbon	89 per cent.
Hydrogen	2 " "
Oxygen and nitrogen	4 " "
Ash	5 " "

the calorific value ranging from 13,500 to 14,400 British thermal units per pound.

On the Continent it is impracticable to obtain pure anthracites such as are found in Wales or in Pennsylvania, and it is necessary to use lean coals, such as can be found in many localities, and are well adapted for use in the suction producer. In selecting a fuel for use in the suction producer certain requirements should be observed. So far as dimensions are concerned, the lumps should range from ½ to 1¼ inches in diameter, this being a commercial sizing which is not so small as to obstruct the passage of the gas in its formation. It should be as free from dust as possible, and contain not more than 8 to 10 per cent. of ash in order that the grate may not be obstructed. The maximum permissible proportion of volatile matter is from 8 to 10 per cent., and the coal should have no tendency to swell or to coke during the combustion; otherwise pockets or arches will be formed, acting to impede the natural descent of the fuel in the producer. In order further to prevent this danger, the producer must be provided with poking or barring holes to enable the fire to be stirred and agitated without admitting air or causing an excessive fall of cinders into the ash pit.

Coals which produce much tar should be avoided, as well as those containing sulphur. The deposit of tar in the pipes, and especially about the valves, is one of the principal causes of unsatisfactory action; while the presence of sulphur, in connection with the brief washing given to the gas, and without chemical purification, causes the production of sulphuric acid, with consequent corrosion of the working metallic parts.

If an excess of air enters the producer through the grate it interferes with the distillation of gas by cooling the zone of combustion, and the dissociation of the steam is checked. If air enters through the charging opening, above the fuel, it dilutes the gas, and may produce dangerous explosive mixtures. It is therefore important



SECTION OF A SUCTION PRODUCER.
Otto-Deutz.

that all parts of the apparatus, including the producer, vaporizer, scrubber, etc., should be tightly closed. In those forms of producers in which the excess of water from the vaporizer is allowed to collect in the ash pan, a sudden fall of incandescent cinders, due to an excessive poking of the fire, may produce an excess of steam, causing a sudden disengagement of water gas. This may be followed by serious shocks in the engine, caused by violent explosions or premature ignition. Generators with a water pan in the ash pit are, however, well adapted for a proper production of vapor, especially if the air supply is previously heated before its delivery to the ash pit. At the present time, however, preference is given to producers equipped with the internally heated vaporizer, although these generally require more time to heat up the water to a temperature of 175 degrees to 200 degrees F., at which an ample supply of vapor is given off.

Externally-fired vaporizers, constructed with tubes or small sections, offer a large amount of heating surface, with thin walls well adapted for the transmission of the heat in the gas to the water to be vaporized. Such vaporizers will produce sufficient vapor to enrich the gas in from 10 to 13 minutes after starting the fire in the producer. With a well-designed tubular vaporizer the producer and motor should be in action at full power in 20 to 25 minutes after lighting up. The principal objection to the use of tubular vapor-

izers is found in the difficulty of cleaning the surfaces from ashes and tarry deposits, and in removing the scale which forms in the tubes. The presence of ammonia or sulphur also tends to corrode the tubes, and for this reason tubes of brass or copper should not be used.

It is a good plan to have the outlet pipe for the gas, after it has passed through the vaporizer, and is therefore partially cooled, arranged to be submerged about an inch below the surface of the water in the base of the vaporizer. This forms a sort of hydraulic seal, and helps to remove any fine dust which may be carried along with the gas.

The scrubber, in accordance with good practice, is made six to eight times the volume of the producer, the height being three to four times its diameter. The best filling for the scrubber is metallurgical coke, in lumps of three to four inches in diameter, the upper fourth of the scrubber being filled with smaller pieces, of about half this size. The quantity of water required for the washing of the gas varies from three to five gallons per hore power hour, when the fuel is anthracite, such as referred to above. In order to prevent the entrainment of water and consequent injury to the engine, a screen or partition should be arranged at the outlet of the scrubber, to prevent water from being carried over with the gas. All elbows and angles in the pipes should also be provided with removable covers, in order that the pipes may be readily and completely accessible for cleaning.

These are the general principles which should govern the design and operation of modern suction gas producers, and apply equally well to those intended to supply motors of 10 horse power as well as those of 150 to 200 horse power. Tests made by the author upon a small suction producer and engine plant by Körting, of only 6 horse power, gave a gross fuel consumption of 1.126 pounds of anthracite per effective horse-power hour. Very complete tests made by the author, in connection with Professor Aimé Witz, upon a double-acting Otto-Deutz engine and a producer of 200 horse power, gave the remarkably low consumption of 0.722 pounds of coal per effective horse power hour. This result was obtained in a test of ten hours duration, in the ordinary course of operation of the plant.

THE STORES SYSTEM OF THE NATIONAL-ACME MANUFACTURING COMPANY.

By A. W. Henn.

This is the second of a group of special articles announced for publication in this Magazine, dealing with successful stores systems in actual use. The purpose in each case is to present the entirety of a working system, with all the forms filled as in regular use, and the applications described by the official in immediate charge. Mr. Henn is the secretary of the National-Acme Co. The company manufacture automatic screw machines and their product.—THE EDITORS.

IT has been aptly said that "the best system which can be devised for any particular shop is that which is best adapted to its individual requirements." No two concerns, it may safely be assumed, would find it equally advantageous to adopt identical forms and methods; hence those referred to in this article are presented simply as the best or most suitable from experience to date for "individual requirements." Little attempt has been made at, and less claim is laid to, originality; selection has been chiefly from articles pertaining to stores-room methods and practices that have appeared in trade papers and industrial journals. Of necessity, all borrowed forms were more or less modified to suit the needs of a "particular shop." All systems have a common aim, and the superiority of one over another lies but in the routine manner of securing the desired information, a prime requisite of any system being results with a minimum of friction and expense. The duties of each one working under the system adopted should be clearly defined, general instructions preferably being given in brief and concise written form; no conflict of authority or misunderstanding among subordinates should be allowed to serve as a reason or excuse for in any manner holding up work or staying the progress of an order.

Contemplating for a moment the requirements for which provision as to stores had to be made in the business considered in this article, we find the manufacturing end logically divided into two departments, one styled Machinery and the other Product. Book accounts for each are kept so far as practicable as though they were for independent concerns. The chief items of raw material consumed in the former are castings and bar steel; in the latter, brass, iron, and steel rods. Of castings and heavy steel for account of the

Machinery department, sufficient are consumed and carried to warrant their being treated as a separate division; the same applies to rods stocked solely for product-department account. All other material is handled through the factory stores room and referred to as small stores. There are then three separate sources of supply:—

I.—Small stores (termed "stores"); for general distribution.

II.—Rods (termed "stock"); Product department primarily.

III.—Castings, bar steel; Machinery department primarily.

While material on both II and III is carried for direct account of the respective department, occasional deliveries are made from either to the other, the items being invoiced at cost plus carrying charges, with adjustments effected monthly. Such transactions are treated as of the nature of transfers and have no bearing whatever upon sales proper.

1. Small stores.—The main details of purchase, receipt, and distribution are centered in this division. A purchasing agent with a retentive memory is possessed of a valuable asset, and by virtue of it is relieved of much drudgery; but it must be used as an aid only and not trusted implicitly. To fortify it he is supplied with a card file of quotations kept within convenient reach of his desk. This quotation card is headed with the article quoted on and alphabetically filed; it shows:—date of quotation; by whom quoted; prices; terms; remarks.

The factory source from which any order not out of the ordinary may have its inception is not restricted. A want memorandum—ordinary blank form—stating plainly what is required, reaches the purchasing agent after having been O. K.'d by foreman, superintendent or officer of the company, depending on convenience or circumstances. The privilege of exercising reasonable discretion is delegated to the purchasing agent, so that unless manifestly wrong the order is promptly placed by him according to memorandum.

The order blanks (Form 1) which are made in triplicate with carbons, are bound in books, 100 sets of orders to each. There are numerous concerns from which material is ordered with more or less regularity, and to each of these an entire book is allotted. The name is typewritten, pasted on the back, and the book filed in a drawer with the labeled end up. By having an assistant fill all blanks in advance as far as possible, the work of ultimately completing the order is reduced to a minimum. Miscellaneous purchases are made through a current order book labeled "sundries."

When an order is made out the duplicate remains in the book; the original and triplicate are detached. Before removing the tripli-

ORIGINAL.

Order No. 7000

Cleveland, O. Mch 18 1905

Confirming phone order to

M F. R. & M. Co

Pittsburg Pa

Please send via Penn R.R. to Woodlawn Sta

200	Hangers 8½ to 10 x 1¼ bore	

Always have Order No. appear on Invoice.

The National-Acme Mfg. Co.

Per Keep

FORM I A. ORDER BLANK.

Original is 6 by 5½ in., thin white paper. Detached by tearing off at the left-hand margin.

cate, a brief notation—initials, department or purpose—is made in the lower left-hand corner. Any reference to price is usually noted on the duplicate only. The original is now sent to the party that is to supply the goods; the triplicate, which is perforated for Shannon file, goes to the store keeper who files it alphabetically. His written standing instructions are to report promptly if goods ordered are not received within a "reasonable time." That may be merely the fraction of a day or several weeks when no specific time is given. The storekeeper, if competent, will not unnecessarily trouble the office nor neglect to keep the purchasing agent duly informed if the goods are not delivered on time. Until direct orders are given him to desist he is required to report daily in writing—name, date and order number only—the non-receipt of all material overdue.

DUPLICATE.

Order No. 7000

Cleveland, O. Mch 18 1905

Confirming phone order to

M F. R. & M. Co

Pittsburg Pa

Penn R.R. Woodlawn Sta

200 Hangers 8½ to 10 x 1¼ bore

For Stores

Price Chgd 3/16

Rec'd 3/17

Invoiced 3/22

Per Keep

FORM I B. CARBON DUPLICATE OF FORM I A.

Following the receipt of the goods, the store keeper sends the triplicate to the office, after having endorsed thereon the date

TRIPLICATE AND GOODS RECEIVED MEMORANDUM ○ Order ○ No. 7000

Cleveland, O. Mch 17 1905

Confirming phone order to

M F. R. W. M. Co

Pittsburg Pa

Ordered Penn. R.R. Woodland Co. off Rec'd

Rec'd by JG
Ck'd by
Del'd by: TEAM—Ours ✓ Theirs
Exp.
Frt. Pa
Messenger

			Unit	Rate	Amount	
200	Hangers 8½ to 10 x 1¼" bore	200	Doz	1.45	290	00

For Stores

Remarks LBoh

3/27/05

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FORM I C. TRIPLICATE, WITH STUB.

and quantity received, by which freight line or express company, etc. To guard against possible loss of any triplicate while in transit, or against neglect to return it promptly to stores room, the store keeper makes a daily slip with carbon copy for the purchasing agent, on

Article Hangers 8½ to 10 x 1¼" bore — Unit pcs — High 200

Section Shelf Row Drawer Bin

Location: 24 Surplus No. — Low 50

RECEIVED					ISSUED				
Date 1905	From Whom Bot.	Quan.	Rate	Value	Date 1905	Quan.	Value		On Hand
3/1		70	1.45	101 50					70
27	F R & M Co	200	"	290 —	3/14	18	26	10	52
					28	40	58	—	212

Notified to Order (over)

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FORM 2. RECORD OF STORES BOUGHT.

Salmon card, 8 by 5 in. The column ruling is carried on the back, also. Form 3, Record of Stores Manufactured, is similar, but on a buff card.

MEMO. OF FINISHED PARTS TURNED IN.

Date	Quantity	Style No.
3/15/05	200	3-845

Remarks 25 pcs taken for mchs, serial

Rec'd in Storeroom Nos. 864 to 888 inclusive

No. Pcs. 175

Per Alex. F. H. R.

Foreman.

FORM 4. MEMORANDUM OF FINISHED PARTS TURNED IN.
Original is 5 by 3 in., thin white paper, blocked in pads.

which he records simply the order numbers of those sent to the office, checking them off when returned and making demand for any not promptly sent back. At the office, through the purchasing agent, the values at the right are filled in, when this form again goes to the store keeper, now furnishing him the necessary data for the stores-bought card. (Form 2.)

Form 3 (buff), essentially the same as Form 2, provides for a record of material manufactured as distinguished from goods bought. For the former, invoices give the value, while prime costs on the latter are obtained from the cost records. Both provide for a running or perpetual inventory.

A "Memorandum of Finished Parts Turned In" (Form 4) accompanies each contingent from the factory which goes into the stores room. It sometimes occurs that the lot as put through according to the records does not correspond in count with the quantity turned over to the store keeper. The difference, accounted for and attested to by initials of the foreman, is generally represented by parts used for current construction work taken in advance of their having gone through the stores room, but only by consent or knowledge of the foreman. The record will show the lot turned in complete—the difference, as having been issued.

For calling attention to items running low or out, an "Order Reminder" (Form 5) is provided. This is on onion-skin paper and is made in carbon duplicate by the store keeper, the original going

to the party interested, the duplicate being retained. Unless an order is placed within a "reasonable time," evidence of which and his only notification being an order triplicate, second or more notices are given until an order is placed or instructions have been received to desist. A busy foreman may be excused for neglecting or forgetting to start the order promptly, or for misplacing the memorandum on receipt of first notice, but not after a second or third. The store keeper must not forget, nor long permit the foreman to do so.

A requisition-for-stock blank is shown in Form 6. Anyone around the factory in want of material can fill out one of these; it requires a foreman's approval, initials only, to make it pass current. A requisition for material other than that in the stores room results occasionally in a cross departmental charge. An order of this nature must further be approved by the regular head of the opposing department, which serves to guard against inadvertently appropriating material in sight that may have been intended and more urgently needed for the regular requirements of the contributing department. The liberal spacing between lines on this form is for the convenience of the factory employee, who as a rule dislikes being restricted for room when it is necessary to use a pencil. This is not to be considered as any reflection on the mechanic—far from it, for he is usually as well qualified to handle proficiently the tools pertaining to his calling as is the clerk his pen. (It may be of interest to note here that the detailed stores-room inventory taken at the close of the last fiscal year to verify the record cards and compare with the ledger

ORDER REMINDER.

Running Low on ✓ ck. All Out of ..... ck.

Article Hangers 8½ to 10 x 1¼ bore

High 200 Low 50 On Hand 52

(Now give date) (Later give date)

Suggest Ordering 3/15/05 Quan. 200

Bot from P. P.

Bot from F.R. & M. Co.

Chg. to Stores Per G.

FORM 5. ORDER REMINDER.

Original is 5 by 3 in., thin white paper, blocked in pads.

UNIT	NO.	REQUISITION FOR STOCK. Date 3/15 190 5				
PRIME COST OR VALUE		QUAN DEL AND RATE		QUANTITY WANTED AND DESCRIPTION		CK.
1	50	1/2	300	6	L 7H Drills #10 1/2	G

(A) Mill Sup. (B) Mach. Const. (C) Cust Order (D) Equip. (E) Rep. or Renewal (F) Dies P. Dept. (G) Drills P. Dept. (H) Sundries.

Mach. Dept. _____ Stock Card ✓

Prod. ✓ Dist'n Sheet ✓ O.A.S. Foreman

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FORM 6. ORIGINAL IS 6¼ IN. WIDE BY 6 IN. HIGH, YELLOW PAPER.

stores account showed a difference in value of less than ten dollars).

II. Rods; Product Department.—The consumption of material under this division approximates upwards of a car load daily—sufficient to keep several men steadily employed receiving and distributing. Several floors of multiple-spindle screw machines demand an incessant supply of rod. The head of this division is held accountable for receipts and disbursements, but he has nothing to do with ordering; that is taken care of through the factory office. To operate with profit a contingent of automatic machines, it is very essential that they be kept steadily running. Power excepted, expenses both direct and overhead continue unabated whether the machinery is turning out product or for any reason stands idle. A careful analysis of the records brings out with emphasis the necessity for exercising much care to guard against the stoppage of machines for want of material. The trouble is augmented rather than otherwise if, when an average order has been run off in part only, it is discovered that

a lack of rod prevents completing it. To hold the machine waiting is unprofitable; to "break up" and put it on to other work, necessitating a second "setting up" on the first order, is possibly even less profitable. Manifestly, the factor of supply must have careful consideration.

With the aid of a card, as per Form 7, a satisfactory check can be kept on conditions in the (rod) stock house. A separate one is made for each size rod used, and also each style—round, square, hexagon, etc.—and each kind—brass, iron, steel, etc. The tabs are used for the sizes which are conveniently arranged first by eighths, next by sixteenths, then by thirty-seconds, followed by sixty-fourths, and after these, decimal sizes according to numerical value. It is aimed to keep a stock of all sizes more or less constantly used within established high and low limits. The record as kept under the head-

7/16

Style Round Kind Brass Limit High 10 000 lbs. " Low 2 000 lbs.

QUANTITY						DISTRIBUTION						
DATE 1905	ORDERED	O K	RECEIVED	O K	BALANCE: REQ'D BASIS	REQUIRED	O K	DATE 1905	ORDER NO.	USED	O K	DATE 1905
3/2	(Lus)	b	2000	b	4200	3000	1	3/13	6240	3080	1	3/25
2/3	5000	a	3000	a	3250	950	2	20	6390	960	2	27
"			2200	a	2525	725	3	"	6420	742	3	"
3/16	2500	b	2550	b	5075	1020	4	22	6514	148	6	28
			9750		2905	150	5	"	6515	1035	4	30
			5965							5965		

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FORM 7. RECORD OF RODS IN THE STOCK HOUSE.
White card, 6 in. wide by 5½ in. high.

Date Mch 20/05

Office Order 6405

Material	Size	Quantity
Iron	½ sq	4000 lbs

STOCK SENT TO MACHINE

Date	Quantity	Date	Quantity	Date	Quantity	Date	Quantity

Factory Order	Board	Machine
17642	13	10

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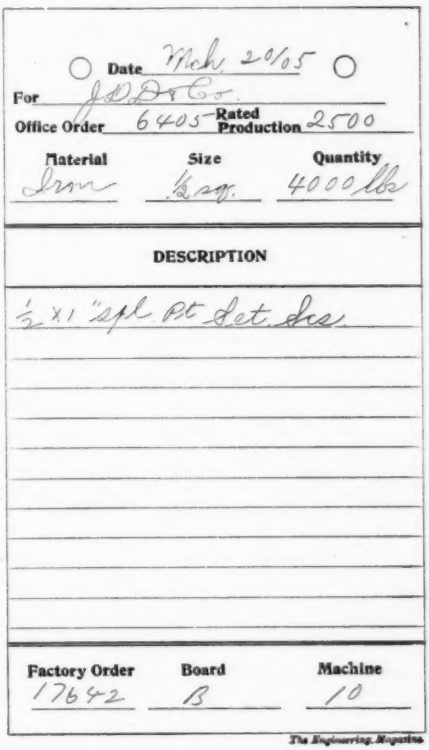
FORM 8 A. REQUISITION FOR ROD.
Original is 4 by 6½ in., Thin Yellow Paper.

ings "Quantity—Distribution" needs perhaps a brief exemplification. Assume that 5,000 pounds of rod have been ordered; that shipments of 3,000 and 2,200 pounds respectively have subsequently been received. The quantity ordered has been slightly over-run; it sometimes falls a trifle short; in either event the mill is apt to treat the order simply as filled. In the two left-hand "ck." columns, check, preferably by using letters, the quantity ordered against the shipments made. Assume next that 3,000 pounds are required for an order. This amount is at once written in the "Required" column (date and order number being filled in) and deduction is made from stock, the remainder being shown under "Balance, Req'd Basis.". Note, that the order might have come to hand and likewise have been recorded in advance of the receipt of material. The balance then would presumably have been a negative quantity, in which event red-ink figures are always used. Rod is delivered from stock to the machines in quantities to suit convenience, each lot first having been listed on the requisition slip (the issuing of which will be referred to directly) and when the order is filled, the slip is returned to the factory office where it originated. The date (final one only) and total amount in pounds used are then entered on the card. The probabilities are remote that the pounds required and those used will tally, for the reason that each machine takes 40 feet of rod (four 10-foot bars) to a single load. But care must be exercised, as only a reasonable amount of deviation, say not to exceed 5 per cent., is permissible. Checking now the "Used" against the "Required," (prefer-

ably by numbers, letters having been used on the "Quantity" side) and the assumed transactions are practically completed. It will be noted that no provision has been made on the card for an actual balance. This is readily arrived at by deducting the "Used" from the "Received" and proved by adding to or deducting from the "Balance, Req'd Basis" amount, the difference between the "Required" and the "Used"; subtract if amount "Used" is greater, add if less. In practice it is found quite satisfactory to run through several orders before making the adjusting notation and bringing down the true balance for a new start. It should be borne in mind that several orders using the same size rod are commonly in incomplete shape at one time. If for any reason it is required at this stage to know the true condition of the stock, it can be ascertained at short notice and with no unnecessary labor.

All requisitions for rod are issued from the factory office. They are made in triplicate with carbons at practically one writing, although no two are just alike. (See Form 8). The blanks are perforated for Shannon file and padded, first yellow, next white, then pink. All orders for special goods take consecutive main-office order numbers in addition to factory order number, while orders for stock goods take the latter only. This enables anyone interested to discern at a glance whether the goods will be for shipment or shelf. The nature of the product would not necessarily tell; stock goods so considered ordinarily are generally treated as though special


Date March 20/05
For J.D.D. & Co.
Office Order 6405 Rated Production 2500

Material	Size	Quantity
Iron	½ sq.	4000 lbs

DESCRIPTION

½ x 1 "spl Bt Det. Dcs.

Factory Order	Board	Machine
17642	B	10

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FORM 8B. PARTIAL DUPLICATE OF 8A. SAME SIZE WHITE PAPER.

8c ("pink ticket") is identical except that it is initialed by the operator.

when required to fill an order, and strictly special parts are considered as regular when the orders are for deliveries at stated periods covering a considerable length of time. The yellow ticket is sent to the (rod) stock house. It is dated and numbered, and contains information as to kind, size and quantity of material, likewise destination of the rod, row (board), and machine. The boards are designated A.B.C., etc.; the machines number from one up on each board. After removing the yellow slip and one carbon, the white ticket is completed by inserting name, usually initials only, and an amount after "Rated Production." This is not an arbitrary figure, but taken, if the product is a special, from a card giving information in detail relative to the making of the piece, recorded when the quotation was made (Form 9). The rate on standard screws is taken from previously established records. Thus is the element of guess-work so far as the operator is concerned entirely eliminated; if he can improve on the quantity, well and good; but he must consult his foreman if for any reason he fails to reach it.

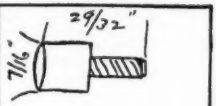
Under "Description" all necessary working instructions are given; if special, make to sample, specifications or drawing, with or without deviation; if standard, then kind, length, style of point, thread, etc. The white slip remains on file in the office of issue; the pink one goes into the mill. It is important to know what operator was identified with the making of the product; his initials or number must be affixed to the pink slip when the order is started.

Name The A. B. Co.

Town New York

Constants 48 lbs @ 15¢ 24 " Scrap

Quoted 4/4/05 Article Screw Post Bro.



Description

	10 M.	25 M.	50 M.
Cost Metal	720	720	720
Auto Labor	××	××	××
Sundry Labor	--	--	--
General Expense	××	××	××
GROSS COST	×××	×××	×××
Scrap 24 lbs @ × c	×××	×××	×××
NET COST	×××	×××	×××

Speed 6000

48
15
720

Mach. finish.

QUOTED

10 M. Lots	25 M. Lots	50 M. Lots	M. Lots
×××	×××	×××	

FORM 9. INFORMATION CARD FOR RECORDING QUOTATIONS.

Original is 5 by 3 in., perforated for card-index rod; white paper. The reverse is ruled for the listing of "sundry labor" on a series of special operations.

MONTH OF Mch. 1905

Date	KIND	Size	Quantity Made	Quantity Estimated	Increase or Decrease	REMARKS
1	[illegible]	932 Rd	2962	2500	462	
2	"	"	2834	2500	334	
3	"	"	1962	2500	538	Down 4 hrs Repairs
4	"	"	2507	2500	7	
5						
6	"	"	2616	2500	116	
7	"	"	2830	2500	330	
8	"	"	2610	2500	110	
9						
31						

Board F.

Mach. 14

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FORM 10. DAILY INDIVIDUAL MACHINE RECORD.

The original is 5½ in. wide by 10½ high, white paper. The figure "538" in the right-hand column should appear in red ink.

The yellow ticket is returned to the office when a proper quantity of rod has been delivered in the mill, and the pink one goes back as soon as the order is off the machine; all three are then systematically filed away.

An operator must keep his machines going if possible. He knows that the daily individual machine record (Form 10) will tell, even if he neglects to, whether or not they have been kept steadily running, and if not the reason why is noted on the sheet; "no rod" will not answer if any was to be had. The stock keeper (rod) delivers material as a rule only on a properly executed order, but this is subject to one exception of limited occurrence. Should an operator for any reason be short of rod he is to use the nearest telephone on his own floor and make direct request for the delivery of one set (four) rods, giving size, kind, and where wanted. This verbal order is, if possible, given immediate attention; at the same time a memorandum of

the stock so delivered must go to the factory office where its receipt means an investigation at once. The matter is usually settled then and there and the records corrected if necessary.

III. Castings, Bar Steel; Machinery Department.—A general order to the superintendent for the making of a lot of machines is accompanied or promptly followed by a detailed list of the required castings and bar steel; lists for all other material follow in due course thereafter. A surplus stock of castings is carried at all times; hence the quantities of some to be ordered will vary from the list, the difference, whether more or less, being contingent upon the number on hand. The bin and storage arrangement of the castings house is such that the proper place for any particular casting can be readily located. Attached to each separate division is a card holder which contains a card (Form 11) showing:—pattern number—ordered—received—taken out—on hand—and affording a satisfactorily close running inventory. The party in charge of castings makes daily report of all receipts and deliveries. Receipts must correspond in pounds with foundry advices, and deliveries on orders must not (without written instructions) exceed in count the unfilled balances according to his records. The memorandum of castings-delivered ticket (Form 12) is an informal "foreman's sub-order" which incidentally serves notice that the factory will soon be ready to commence the machining of certain parts and calls for their delivery at a particular place. Car-

CASTING HOUSE RECORD

PATTERN NO. 23-47

DATE 1905	Ordered	Received	Taken Out	On Hand	DATE	Ordered	Received	Taken Out	On Hand
7/15	100								
20		21		21					
21		32		53					
24		23	40	36					
25		27		63					
28			20	43					

FORM II. CASTING HOUSE RECORD.

The original is 4 by 7 inches, buff card, printed alike on both sides.

bon duplicate is made, one slip going with the goods, the other to the office. Unless the full quantity ordered is delivered, inquiry concerning the balance should be made before starting, to guard against holding machines idle or the possible necessity for setting up two or more times.

The office record of castings is independently kept and in more detail (see Form 13). Only when the metal is other than grey iron are the spaces under "From Whom Ordered" and "Material" filled out. The sending of patterns to and their return from the foundry must be recorded on this form. The "weight per piece" memorandum in lower left-hand corner affords a ready means for converting pieces into pounds when so required. On small parts, where the variation in weight is slight, one amount only is noted; on heavier castings the greatest and least ascertained weights are recorded, and an average used for inventory or other purposes. Article and pattern numbers are always identical. Like parts on all sizes of machines built have the same descriptive or base number, the prefix indicating the size or sizes on which the piece is used. Thus 1-9 and 6-9 both stand for a cylinder, but of radically different dimensions. When, as is frequently the case, the same part serves for use on two or more sizes of machines, the piece number clearly indicates it. 23-18 is a sector gear found on machines Nos. 2 and 3, while 25-364 is a lock bolt of the same dimensions whether for Nos. 2, 3, 4 or 5 machines. When the first two numbers are not consecutive, the miss-

Memo. of Castings Del'd.

Date Mch 14 1905.

No. Pcs. Ordered 40

Size of Mach: 45

Pattern No. 45-161

Description

Drum under Spindles

Delivered at Planers on 3rd Floor

No. Pcs. Del'd 40

Ordered by Sullivan

Delivered by Terry 3/16/05

FORM 12. MEMORANDUM OF CASTINGS DELIVERED.

Original is 3 by 5 inches, thin white paper, blocked in pads.

PATTERN NUMBER 3-11 NAME OF ARTICLE Tool Slide or Knee HIGH 60 LOW 15

Date 1905	No. Pcs Ordered	From Whom Ordered	Material	Patterns Sent: Pieces	Patterns Sent: Core Boxes	Patterns Sent: Pieces	Patterns Returned: Date	Patterns Returned: Pieces	Patterns Returned: Core Boxes	Patterns Returned: Pieces
3/16	50			2	X X	X	3/20	2	X X	X

Weight per Piece	111-114	
No. Pieces per Machine	1	

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PATTERN NUMBER 3-11 LOCATION OF STOCK a-17

Date 1905	Delivered: At Factory	Delivered: In Works	Balance on Hand	Date	Delivered: At Factory	Delivered: In Works	Balance on Hand	Date	Delivered: At Factory	Delivered: In Works	Balance on Hand	Date	Delivered: At Factory	Delivered: In Works	Balance on Hand
3/20	50	30		20											

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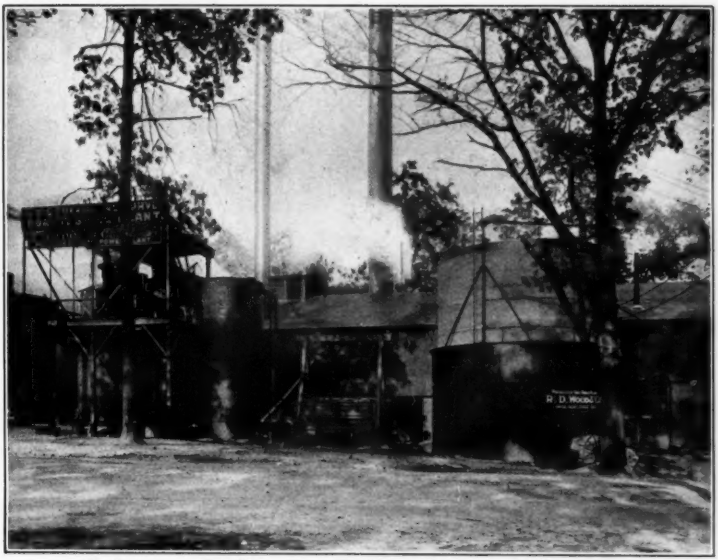
FORM 13. OFFICE RECORD OF CASTINGS.

Stiff card, 8 by 5 in.; the upper figure shows the face, the lower the back of the card.

ing ones are always understood as representing intervening sizes of machines.

Simplicity and practicability have been aimed at in the forms adopted and their application to the receipt and distribution of material. Simple enough to be readily understood and followed, at the same time yielding results sufficiently accurate to be practically correct, and near enough to the automatic in operation to afford little excuse and less reason for unsatisfactory records.



Producer Scrubber Purifier Holder
Economizer Tar Extractor

THE GAS-PRODUCER PLANT.

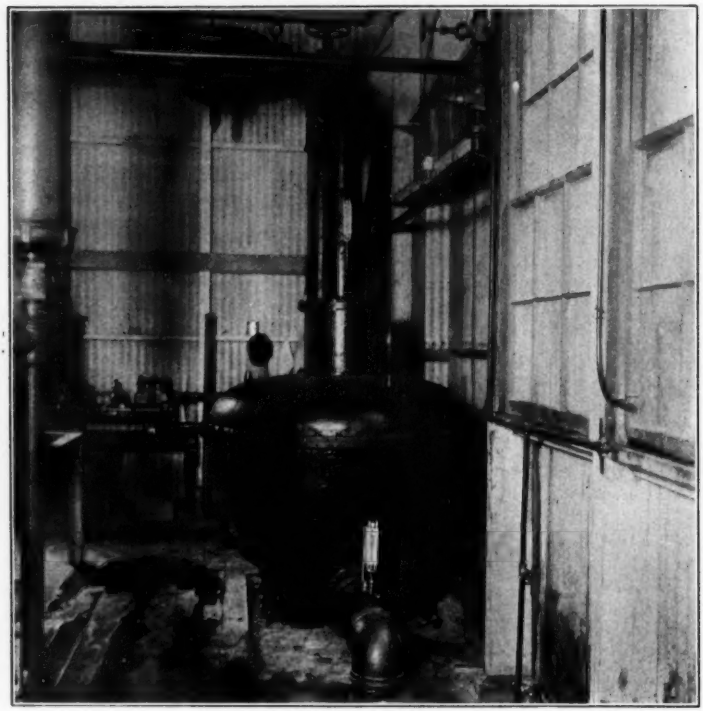
TESTING COALS AND LIGNITES AT THE ST. LOUIS WORLD'S FAIR.

By E. W. Parker.

IN the preceding number of THE ENGINEERING MAGAZINE, the genesis of the coal-testing plant at the St. Louis Exposition was described, the general scope and organization explained, and an outline of the equipment given. The work accomplished and the results obtained were summarized, so far as concerns the chemical analyses and the steam-raising tests, leaving for this issue the synopsis of the gas-producer, briquetting, and coking trials, and the experiments made with various binders for briquetted fuel. These data are concisely presented in the following pages, many of them being arranged in tabular form that they may be more easily interpreted and compared.

Gas-Producing Tests.—The investigations into the gas-producing qualities of the different coals tested were limited to the operation of a producer-gas plant, and using the gas in an explosive gas engine.

The gas, which was made in a Number 7 Taylor gas producer, passed first through an economizer, and then through a scrubber, a tar extractor, and a purifier, into the holder, from which it was drawn into and consumed by a Westinghouse three-cylinder, vertical gas engine, rated at 235 brake horse power.



THE GAS METER.

Under the plan adopted for the tests the quantity of gas produced from each coal was carefully determined, and complete records have been obtained regarding the quality of the gas produced, its value in British thermal units, etc. For this purpose a separate laboratory was maintained and two special chemists were employed to make calorimetric determinations and analyses of the gases.

Complete records were kept of all coal charged to the producer, the steam and water used, the power required to drive the appliances connected with the operation of the producer, the gas generated, and the power developed. Besides these records, readings of thermome-

ters, pressure gauges, calorimeters, etc., were made every twenty minutes during the running time. From these readings complete deductions of the tests have been made.

As was to be expected in such pioneer work as these tests entailed, a number of difficulties developed. Principal among these were the adjusting of the producer operations to the different coals, and of the engine to the greatly varying qualities of the gases. It must be remembered that the maximum time allowed for the gas-producer tests was three days, which included the time necessary to consume all unexpended fuel of a preceding test, and to prepare the bed from the coal next to be tested. Out of the three days only thirty hours were available for actual tests, and these could be secured only by making the test of thirty consecutive hours, requiring the men engaged to be on duty constantly that length of time twice each week.

The difficulties of adjusting the engine to the different qualities of gas were even more disturbing than those which attended the operation of the producer. The main trouble here was in setting the igniters at the proper time relative to the compression of the gas in the cylinder, and any change in the sparking apparatus necessitated the stoppage of the engine. Notwithstanding these and other minor troubles, some valuable results have been obtained, as well as much useful experience which will be available for future work. Mr. Culbertson, the Westinghouse engineer in charge of the gas engine, has had made an adjustable sparking device which it is believed will obviate the difficulties experienced from this cause during the tests. Should Congress appropriate the funds for continuing the operations of the testing plant during the current year, a great many of the mechanical troubles experienced in the past will be avoided.

In the table on pages 214 and 215 is a summary of eighteen gas-producer tests made during the period from October 3 to December 22, inclusive. Probably the most interesting feature of this table is in the results obtained from the poorer grades of coal, and particularly from lignite. Special attention is called to the comparatively high calorific value of the gas obtained from "Texas No. 1" and "North Dakota No. 2," both of which are brown lignites. The average heating value of the former, as expressed in British thermal units, was 169.7 per cubic foot, and that of the latter was 188.5. The best gas obtained from bituminous coals was made from Indiana No. 2, which averaged 159.3 British thermal units per cubic foot, and Indian Territory No. 1, 159.2 British thermal units. On account of the large percentage of water and of ash in the lignites, the amount as mined

BRIEF SUMMARY OF GAS PRODUCER TESTS OF EIGHTEEN BITUMINOUS COALS AND LIGNITES.

Tests.		Samples.			Coal per hour, lbs.				British Thermal Units.								Cu. ft. standard gas produced. (62° F. 14.7 lbs. pressure.)					
					Consumed in producer.				Equivalent used by producer plant.				Per lb.				Per lb. consumed in producer.			Per lb. equivalent used by producer plant.		
Number of test.	Date of test.	Duration in hours.	Name of sample.		Coal as fired.	Dry Coal.	Combustible.	Coal as fired.	Dry Coal.	Combustible.	Coal as fired.	Dry Coal.	Combustible.	Per cu. ft. of standard gas.	From standard gas per lb. of dry coal consumed in producer.	From standard gas per hour per brake horse power.	Per hour.	Coal as fired.	Dry coal.	Combustible.	Coal as fired.	Dry coal.	Combustible.
1	2	3	4		5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2	Oct. 10-14	43.00	Alabama	No. 2	310.5	299.0	280.0	341.4	328.7	306.8	12865	13365	14820	149.2	9000	11420	18050	58.1	60.4	64.5	52.9	55.0	58.9
15	Dec. 13-14	30.00	Colorado	No. 1	364.4	290.7	269.3	428.4	341.7	316.6	9767	12245	13210	149.0	7860	9700	15343	42.1	52.8	57.0	35.8	44.9	48.5
*6	Oct. 31-Nov. 1	30.00	Illinois	No. 3	350.0	323.3	289.3	386.0	356.7	319.2	12046	13041	14560	154.8	8330	11460	17412	49.8	53.9	60.2	45.1	48.8	54.5
*9	Nov. 10-11	30.00	Illinois	No. 4	350.0	306.3	274.1	398.2	348.5	311.9	11237	12834	14344	151.5	8840	11620	17881	51.1	58.4	65.3	44.8	51.4	57.3
*14	Dec. 2-3	29.67	Indiana	No. 1	394.5	349.3	309.5	434.6	384.8	341.0	11534	13037	14720	153.7	7730	11480	17560	44.5	50.3	56.7	40.4	45.6	51.5
*13	Nov. 28-29	7.00	Indiana	No. 2	300.0	274.0	244.8	338.0	312.0	278.8	11822	12953	14500	159.3	10140	11750	17450	58.2	63.6	71.3	51.6	55.9	62.6
1	Oct. 3-6	31.00	Ind. Ter.	No. 1	361.0	344.0	312.0	392.7	374.0	339.3	12787	13455	14800	159.2	8620	12350	18613	51.6	54.1	59.4	47.4	49.9	54.6
*12	Nov. 25-26	30.00	Kentucky	No. 3	370.0	343.3	310.0	410.8	381.2	344.2	12283	13226	14650	155.9	8610	12540	18943	51.2	55.1	61.1	46.2	49.7	55.0
*7	Nov. 3	4.33	Missouri	No. 2	346.5	306.0	255.0	384.5	339.6	283.0	10505	11882	14280	140.0	8820	11560	19300	55.7	63.0	75.7	50.2	56.8	68.2
*5	Oct. 24-25	22.33	Montana	No. 1	456.5	404.5	355.8	506.8	449.1	395.0	10575	11934	13580	160.8	6580	11340	16540	36.2	40.9	46.5	32.6	36.8	41.9
*10	Nov. 14-15	30.00	N. Dakota	No. 2	460.0	278.0	249.0	510.0	308.0	275.8	6802	11255	12600	188.5	7830	13770	11550	25.2	41.5	46.4	22.7	37.5	41.9
*11	Nov. 21-22	21.67	Texas	No. 1	590.0	392.0	332.0	660.0	439.5	371.3	7267	10928	12945	169.7	7260	12230	16800	28.4	42.7	50.6	25.5	38.2	45.3
18	Dec. 21-22	19.33	Texas	No. 2	468.0	310.3	276.2	519.5	344.4	306.6	7348	11086	12450	156.2	8060	10570	16009	34.2	51.6	57.9	30.8	46.4	52.2
3	Oct. 17-18	24.00	W. Va.	No. 1	287.5	283.0	265.5	320.6	315.6	296.1	14166	14396	15350	144.4	9260	11130	18150	63.2	64.1	68.4	56.6	57.5	61.3
4	Oct. 20	9.00	W. Va.	No. 4	233.0	229.0	208.0	262.8	258.2	234.5	13918	14202	15600	143.2	11610	11320	18560	79.6	81.2	89.2	70.6	71.9	79.2
17	Dec. 19	6.33	W. Va.	No. 9	300.0	292.0	274.9	328.9	320.1	301.4	14195	14580	15500	151.0	8150	10060	15770	52.6	54.0	57.4	48.0	49.3	52.3
*8	Nov. 7-8	30.00	W. Va.	No. 12	270.0	266.1	248.7	304.9	300.5	280.9	14614	14825	15860	142.5	10150	11500	18957	70.1	71.2	76.2	62.1	63.2	67.5
16	Dec. 16-17	30.00	Wyoming	No. 2	403.3	365.3	281.6	459.8	416.5	321.1	9650	10656	13820	151.0	6168	9516	14923	37.0	40.9	53.0	32.5	35.8	46.5

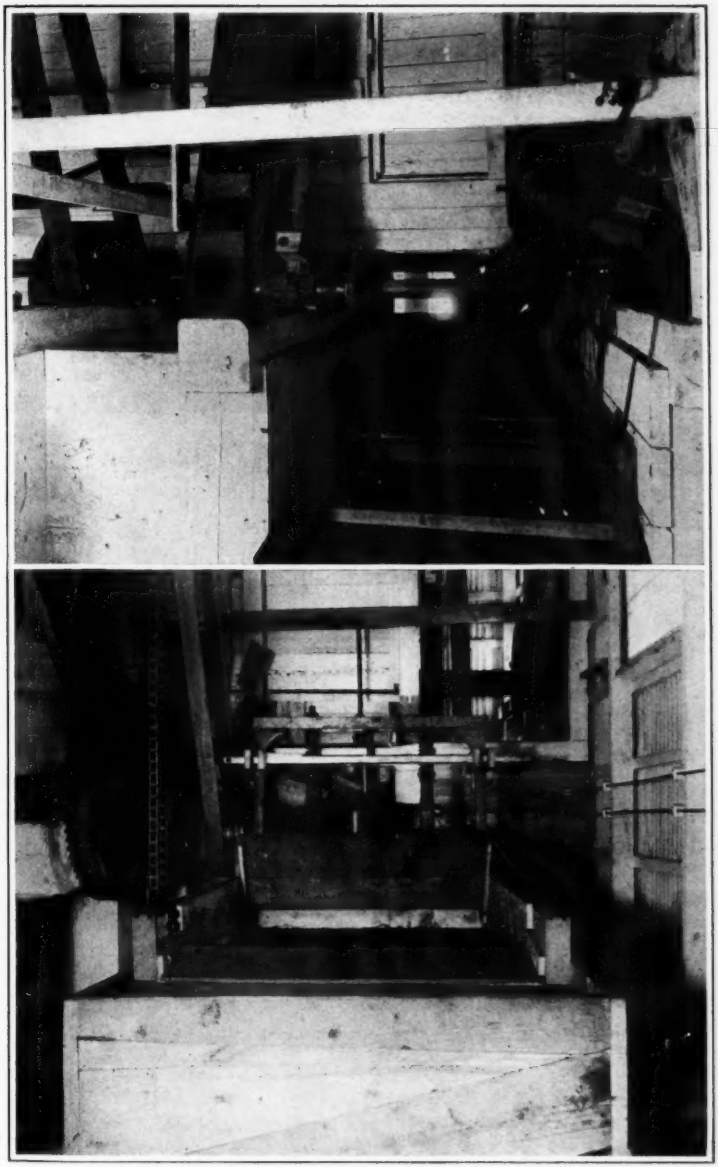
Number of test.	Economic results. Lbs. of coal consumed in producer per horse power per hour. Per electrical h.-p. available for outside purposes. Coal as fired.	Dry coal.	Combustible.	Per electrical h.-p. developed at switchboard. Coal as fired.	Dry coal.	Combustible.	Per brake h.-p. available for outside purposes. Coal as fired.	Dry coal.	Combustible.	Per brake h.-p. developed at engine. Coal as fired.	Dry coal.	Combustible.	Economic results. Equivalent lbs. of coal used by producer plant per horse power per hour. Per electrical h.-p. available for outside purposes. Coal as fired.	Dry coal.	Combustible.	Per electrical h.-p. developed at switchboard. Coal as fired.	Dry coal.	Combustible.	Per brake h.-p. available for outside purposes. Coal as fired.	Dry coal.	Combustible.	Per brake h.-p. developed at engine. Coal as fired.	Dry coal.	Combustible.	Average composition of gas by volume, per cent. Carbonic acid, CO_2.	Oxygen, O_2.	Carbonic oxide, CO.	Hydrogen, H_2.	Marsh gas, CH_4.	Nitrogen, N_2.
1	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
2	1.61	1.55	1.45	1.55	1.49	1.40	1.37	1.32	1.23	1.32	1.27	1.19	1.77	1.71	1.59	1.71	1.64	1.53	1.51	1.45	1.35	1.45	1.40	1.30	8.16	.10	16.65	7.20	5.64	62.24
15	1.95	1.56	1.45	1.82	1.45	1.35	1.66	1.32	1.23	1.55	1.23	1.14	2.30	1.83	1.70	2.14	1.71	1.58	1.95	1.56	1.44	1.82	1.45	1.34	10.11	.55	17.38	11.05	5.00	55.90
6	1.82	1.68	1.50	1.75	1.62	1.45	1.54	1.43	1.28	1.49	1.38	1.23	2.01	1.85	1.66	1.93	1.79	1.60	1.70	1.58	1.41	1.64	1.52	1.36	10.53	.15	15.31	8.35	4.46	61.19
9	1.85	1.62	1.45	1.76	1.55	1.38	1.57	1.37	1.23	1.50	1.31	1.17	2.11	1.84	1.65	2.01	1.76	1.57	1.79	1.56	1.40	1.71	1.50	1.34	9.72	.12	15.12	9.98	6.00	59.06
14	2.10	1.86	1.64	1.97	1.75	1.55	1.78	1.58	1.40	1.68	1.49	1.32	2.31	2.04	1.81	2.17	1.93	1.71	1.96	1.74	1.54	1.85	1.64	1.45	9.89	.25	14.10	9.56	6.08	60.13
13	1.57	1.43	1.28	1.49	1.36	1.22	1.33	1.22	1.09	1.27	1.16	1.03	1.77	1.63	1.46	1.68	1.55	1.39	1.52	1.39	1.24	1.43	1.32	1.18	11.80	.07	11.46	10.60	6.10	59.97
1	1.84	1.76	1.59	1.77	1.69	1.53	1.57	1.50	1.36	1.50	1.43	1.30	2.00	1.91	1.73	1.92	1.83	1.66	1.71	1.62	1.47	1.64	1.56	1.41	8.25	.11	19.39	7.69	4.92	59.65
12	1.95	1.81	1.63	1.85	1.71	1.55	1.66	1.54	1.39	1.57	1.46	1.32	2.16	2.01	1.81	2.05	1.91	1.72	1.84	1.71	1.54	1.75	1.62	1.46	10.87	.29	12.45	10.92	6.52	58.95
7	1.87	1.65	1.37	1.74	1.54	1.28	1.59	1.40	1.17	1.48	1.31	1.09	2.07	1.83	1.52	1.94	1.71	1.43	1.76	1.55	1.30	1.65	1.45	1.21	12.07	.20	10.53	7.63	6.33	63.23
5	2.39	2.12	1.86	2.29	2.03	1.78	2.03	1.80	1.58	1.95	1.72	1.52	2.65	2.35	2.07	2.54	2.25	1.98	2.26	2.00	1.76	2.16	1.91	1.68	9.04	.36	18.67	8.00	4.84	59.10
10	3.67	2.22	1.99	3.42	2.07	1.86	3.13	1.89	1.69	2.91	1.76	1.58	4.07	2.46	2.20	3.80	2.29	2.05	3.47	2.09	1.88	3.23	1.95	1.74	8.69	.23	20.90	14.33	4.85	51.02
11	3.16	2.10	1.78	2.98	1.99	1.68	2.68	1.79	1.51	2.54	1.69	1.43	3.53	2.35	1.99	3.34	2.22	1.88	3.00	2.20	1.69	2.83	1.99	1.60	11.10	.22	14.43	10.54	7.48	56.22
18	2.47	1.64	1.46	2.33	1.54	1.37	2.10	1.39	1.24	1.98	1.31	1.17	2.74	1.82	1.62	2.58	1.71	1.52	2.33	1.55	1.38	2.20	1.46	1.30	9.60	.20	18.22	9.63	4.81	57.53
3	1.51	1.49	1.40	1.43	1.41	1.33	1.29	1.27	1.19	1.22	1.20	1.13	1.69	1.66	1.56	1.60	1.57	1.48	1.43	1.41	1.33	1.36	1.34	1.26	10.50	.10	14.34	2.81	5.56	66.69
4	1.23	1.21	1.10	1.17	1.15	1.04	1.05	1.03	.94	.99	.98	.89	1.39	1.36	1.24	1.32	1.29	1.17	1.18	1.16	1.05	1.12	1.10	1.00	10.16	.24	15.82	11.16	3.74	58.88
17	1.60	1.56	1.47	1.49	1.46	1.37	1.36	1.33	1.25	1.27	1.24	1.16	1.76	1.71	1.61	1.64	1.59	1.50	1.49	1.46	1.37	1.39	1.35	1.27	10.40	.20	13.70	9.55	6.60	59.55
8	1.41	1.39	1.30	1.35	1.33	1.24	1.20	1.18	1.11	1.15	1.13	1.06	1.59	1.57	1.47	1.53	1.50	1.40	1.35	1.34	1.25	1.30	1.28	1.20	10.34	.12	14.21	12.98	4.61	57.75
16	2.18	1.98	1.52	2.00	1.82	1.40	1.86	1.68	1.30	1.70	1.54	1.19	2.49	2.25	1.74	2.28	2.07	1.60	2.11	1.92	1.48	1.94	1.76	1.36	10.21	.59	15.46	10.79	5.52	57.43

* Gas producer hopper leaked during these tests.

required to produce a certain quantity of gas naturally exceeds the amount of bituminous coal required to produce the same quantity. For instance, one pound of Texas No. 1 yielded only 28.4 cubic feet of gas; Texas No. 2, 34.2 cubic feet; North Dakota No. 2, 25.2 cubic feet; Colorado No. 1 (lignite), 42.1 cubic feet, and Wyoming No. 2 (lignite) 37 cubic feet, whereas one West Virginia coal yielded 70.1 cubic feet, another (West Virginia) 79.6 cubic feet, while the yield of the other bituminous coals ranged from 44.5 to 63.2 cubic feet.

But the economic results as shown by the horse power developed at the switchboard, and as calculated as available for effective use, are the striking features. In this we find that for each horse power per hour developed at the switchboard there were used of these lignites the following:—Colorado No. 1, 2.14 pounds; North Dakota No. 2, 3.8 pounds; Texas No. 1, 3.34 pounds; Texas No. 2, 2.58 pounds; Wyoming No. 2, 2.28 pounds. For effective horse power per hour, or that available for purposes outside of that used at the plant, the requirements would be:—of Colorado No. 1, 2.3 pounds; of North Dakota No. 2, 4.07 pounds; of Texas No. 1, 3.53 pounds; of Texas No. 2, 2.74 pounds, and of Wyoming No. 2, 2.49 pounds. How these compare with bituminous coals used under boilers is shown by the fact that the best West Virginia coal required 3.39 pounds per electrical horse power per hour at the switchboard, and of seventy-six tests under boilers, only five (all from West Virginia) required less than 3.5 pounds, and only twenty-six (fourteen from West Virginia) required less than 4 pounds of fuel. From this it appears that lignite coals, converted into gas and used in a gas-engine, will do equally as good service as the average bituminous coals used under boilers.

From the preceding tables some interesing comparisons can be drawn on the relative efficiency when used under boilers and in the gas producer, of such coals as had been subjected to both of these tests. As has already been explained it was not possible to make as many producer as steaming tests, and a number of coals have been tested in the producer since January 1, and after the other portions of the plant were shut down, the results of which tests are not yet worked up. Enough has been accomplished, however, to demonstrate the great advantage of the gas producer and gas engine over the boiler and steam engine, for the generation of power, and to substantiate the claims for economy made by the advocates of the gas engine. These facts are not entirely new, but their demonstration in official and unbiased tests is a matter worthy of record.



MECHANICAL INSTALLATION IN THE WASHERY BUILDING. THE UPPER PICTURE SHOWS THE STEWART JIG; THE LOWER, THE NEW CENTURY JIG.

COMPARATIVE OF LEADING RESULTS OF THE COAL TESTS

Name of Sample	Duration of Trials		Total Dry Coal Consumed per Hour		Dry Coal Burned per Sq. Ft. of Grate Surface per Hour	
	Steam Plant	Producer Gas Plant	Steam Plant	Producer‡ Gas Plant	Steam Plant	Producer† Gas Plant
	Hours	Hours	Pounds	Pounds	Pounds	Pounds
Alabama 2.....	10.02	43.0	874	328.7	21.54	7.78
Colorado 1.....	9.97	30.0	722	341.7	17.80	7.56
Illinois 3.....	10.13	30.0	861	356.7	21.23	8.41
Illinois 4.....	10.02	30.0	938	348.5	23.13	7.96
Indiana 1.....	9.93	29.67	908	384.3	22.39	9.08
Indiana 2.....	10.13	7.0	832	312.0	20.51	7.13
Indian Territory 1.	9.75	31.0	778	374.0	19.17	8.95
Kentucky 3.....	10.07	30.0	882	381.2	21.75	8.92
Missouri 2.....	9.98	4.33	1014	339.6	25.00	7.96
W. Virginia 1....	9.98	24.0	768	315.6	18.94	7.36
W. Virginia 4.....	10.00	9.0	770	258.2	18.98	5.96
W. Virginia 9.....	10.00	6.33	721	320.1	17.78	7.60
W. Virginia 12....	10.13	30.0	719	300.5	17.68	6.92
Wyoming 2.....	9.95	30.0	1075	416.5	26.51	9.50

During all the tests, as nearly as possible, the amount of energy delivered to the switchboard by both generators was 200 horse power. Both generators were direct-current, of 250 volts. The power was used in operating the plant and working exhibits in the "Mining Gulch," any surplus being consumed by two water rheostats placed just outside the engine room.

The table on this page and the one facing shows that in the production of this power the amount of coal consumed per hour under the boilers varied from 719 pounds of West Virginia high-grade bituminous, to 1,075 pounds of Wyoming black lignite, while in the gas producer the amount ranged from 258.2 pounds to 416.5 pounds, these two extremes being also made by West Virginia and Wyoming coals. It will be observed that in amount of coal consumed per hour, Colorado (a black lignite) was only a few pounds behind the best two West Virginia coals, but in evaporation results the lignites fell far below, and delivered only 149.1 horse power to the switchboard as compared with an average of over 200 for West Virginia coals.

The last three columns of the table show the amount of dry coal consumed per hour per electrical horse power delivered to the switchboard by the gas engine and steam engine, and the ratio between them. In every case the amount of coal consumed under the boilers was

† Coal actually consumed in producer only.

‡ Includes coal consumed in producer, and coal equivalent of the steam used in the producer.

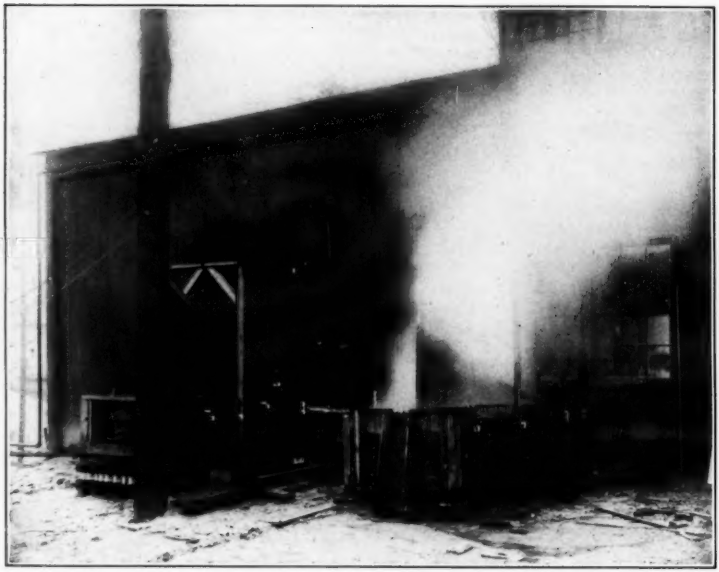
SUMMARY
THE
MADE UNDER THE BOILER AND IN THE PRODUCER

Water Evaporated from and at 212° F. per Pound of Dry Coal		B. T. U. per Pound of Dry Coal		Electrical H.-P. Delivered to Switchboard		Total Dry Coal per Electrical H.-P. per Hour		Ratio of Coal Consumption in Steam Plant to that in Producer Plant
Steam Plant	Producer Gas Plant	Steam Plant	Producer Gas Plant	Steam Plant	Producer Gas Plant	Steam Plant	Producer‡ Gas Plant	
Pounds	Pounds	B.T.U.	B.T.U.	E.H.P.	E.H.P.	Pounds	Pounds	Pounds of Coal per Horsepower Hour
8.55	12,555	13,365	213.7	200.6	4.08	1.64	2.59	to 1
7.21	12,577	12,245	149.1	200.2	4.84	1.71	2.83	to 1
8.04	12,857	13,041	198.1	199.6	4.34	1.79*	2.425	to 1
7.27	12,459	12,834	195.4	198.4	4.80	1.76*	2.73	to 1
8.45	13,377	13,037	220.0	199.9	4.13	1.93*	2.14	to 1
8.02	.....	12,953	....	201.0	4.35	1.55*	.....	
8.64	12,834	13,455	192.3	204.0	4.04	1.83	2.21	to 1
8.27	13,036	13,226	208.9	200.5	4.22	1.91*	2.21	to 1
7.08	11,500	11,882	205.6	198.6	4.93	1.71*	2.88	to 1
8.95	14,198	14,396	196.7	200.4	3.90	1.57	2.48	to 1
9.65	14,002	14,202	212.5	199.7	3.62	1.29	2.81	to 1
10.09	14,616	14,580	208.2	201.0	3.46	1.59	2.176	to 1
9.90	15,170	14,825	203.6	199.8	3.53	1.50*	2.36	to 1
5.92	10,897	10,656	182.0	201.2	5.90	2.07	2.85	to 1

more than double that used in the gas producer, while in three instances it exceeded a ratio of 2.8 to 1. In one of the latter cases the hopper of the gas producer was leaking, and a considerable quantity of gas was lost. But for this the proportion would probably have shown a difference of 3 to 1.

It is to be remembered that the steam generated by the boiler was used in a simple, non-condensing engine of the Corliss type, whose "water rate" was 26.3 pounds of steam per hour per horse power developed; that this engine was belted to the electric generator; and that the mechanical efficiency of this combination of engine and generator was 81 per cent. With these figures available, it will be an easy matter to calculate the number of pounds of coal which would have been required to produce an electrical horse power, provided a more economical type of steam engine had been used, or if the electrical generator had been directly connected to the engine with the resulting advantage of a higher mechanical efficiency. If, for example, the steam generated had been used by a steam engine capable of generating one horse power with 18 pounds of steam per hour, and if the engine and generator had been direct-connected, giving as high a mechanical efficiency as 90 per cent., then the "Total Dry Coal per Electrical Horse Power per Hour" would have been re-

* Gas producer hopper leaked during these tests.
‡ Includes coal consumed in producer, and coal equivalent of steam used in producer.



THE WATER RHEOSTATS USED TO CONSUME THE SURPLUS OUTPUT OF THE GENERATORS IN THE COMPARATIVE TESTS OF GAS-PRODUCING AND STEAM-GENERATING VALUES OF VARIOUS COALS.

duced from 4.3 pounds, as given in column 13, to very nearly 3.0 pounds. While these figures are frequently and easily attained by steam engines operating in large units, it will be conceded that in plants of from 200 to 250 horse power they are seldom reached.

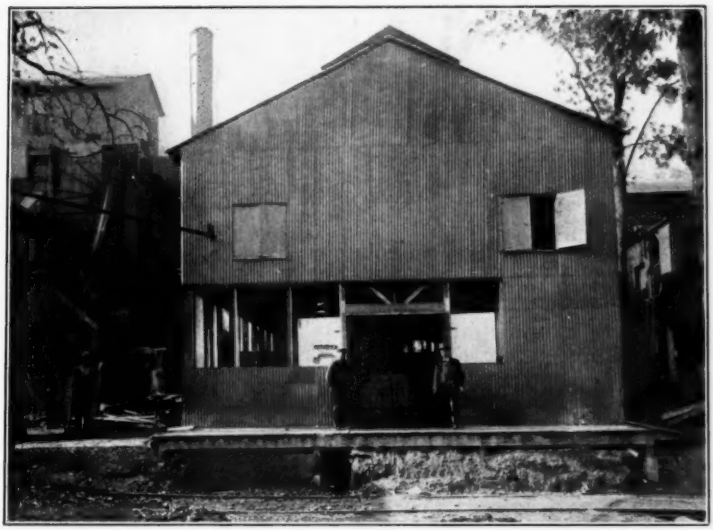
It should be mentioned that the labor required would be the same for the operation of either the boiler plant or the gas-producer plant of the capacity under tests. In either plant two men would be sufficient.

On the other hand, in considering the possible increase in efficiency of the boiler trials with a compound engine substituted for the simple engine used, the fact should not be overlooked that a corresponding increase in the efficiency of the gas-producer trials may be brought about under the most favorable conditions. The gas engine is passing through a transitional period. In the larger sizes, the vertical single-acting engine is being replaced by the horizontal double-acting. Other changes and improvements are constantly being made which tend to accomplish for the gas engine what compounding and tripling the expansions have already done for the steam engine.

The gas engine used in the trials recorded is a vertical three-cylinder, single-acting engine, with no means of changing the ignition while the engine is running. A brief consideration of these points will lead at once to the conclusion that the gas engine and steam engine used in these tests compare favorably, and that any increase in efficiency in the boiler trials that might result from using a compound engine can be offset by the introduction of the more modern type of gas engine.

Coking Tests.—The equipment provided for testing the coking qualities of the coals consisted of three beehive ovens of standard size—12 feet in diameter and 7 feet high—constructed from plans furnished by Mr. John Fulton, of Johnstown, Pa. It was the desire of the committee to have installed a battery of by-product-recovery retort ovens, but the construction of such a plant would have entailed the investment of between $50,000 and $100,000. It was not possible to secure this donation, but even if it had been furnished it is doubtful if the plant could have been constructed in time to have been put in blast prior to the close of the Exposition.

Tests in the beehive ovens were made with coals from all parts of the country, whether they had been previously considered as coking coals or not. Some of the coals were tested raw, some washed,

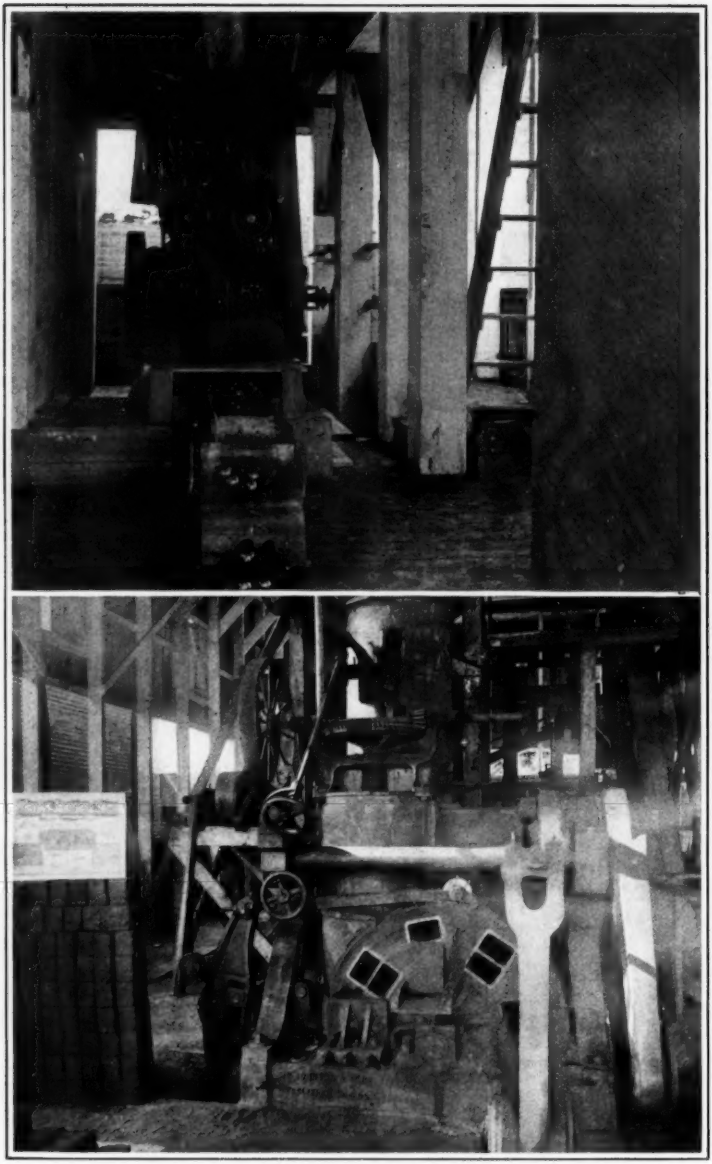


BRIQUETTING BUILDING NO. 1; BARTLETT-SNOW DRYER AT THE LEFT.

COKING TESTS.

Name of Sample.		Condition of Coal.	Chemical Composition of Coal. % Moisture.	% Volatile matter.	% Fixed carbon.	% Ash.	% Sulphur.	Coal charged into oven. Pounds.	Coking time. Hours.	Coke produced. Pounds.	Breeze and ash. Pounds.	Chemical Composition of Coke. % Moisture.	% Volatile matter.	% Fixed carbon.	% Ash.	% Sulphur.	% Phosphorus.	Specific gravity.	Coke produced.	Remarks.
Alabama	1	Raw	2.65	30.79	52.68	13.88	0.76	8000	88											Light, spongy.
Alabama	1	Washed	4.64	31.28	53.02	11.06	0.89	9800	65	5731	352	0.33	0.72	82.63	16.32	0.69	.047	1.94	58.5	Improved by washing.
Alabama	2	Raw	3.77	32.60	50.59	13.04	1.43	8000	64											Charred coal and ash remained.
Arkansas	1	Raw	2.31	18.10	66.58	13.01	1.13	8075	114											No coke produced.
Arkansas	2	Raw	2.31	17.41	69.73	10.55	1.58	8150	118											No coke produced.
Arkansas	6	Washed	18.29	12.95	62.54	6.22	1.22	9000	95											No coke produced.
Arkansas	3	Briq.						Small box	65			1.05	2.80	72.73	23.42	1.52				Placed in oven with charge of coal.
Arkansas	6	Briq.	4.59	17.25	64.12	14.04	1.68	8000	42	4056	539	4.06	2.77	76.63	16.54	1.43	.050	1.88	50.7	50% Briquettes and 50% coal charged.
Illinois	1	Raw	10.46	36.11	37.48	15.95	4.14	9000	43											Small coke and ash produced.
Illinois	2	Washed	17.20	35.77	37.84	9.19	3.03	9000	64	3389	352	1.57	2.83	75.42	20.18	2.75	.030	1.87	37.6	Hard and soft mixed.
Illinois	3	Raw	8.25	30.22	50.94	10.59	1.45	9000	43											No coke, burned on top.
Illinois	3	Washed	9.52	32.05	52.57	5.86	1.41	13000	90	6378	834	6.11	0.42	82.55	10.92	1.13	.019	1.84	49.1	Fingered, brittle.
Illinois	5A	Washed	17.86	31.65	32.93	17.56	3.25	8000	42											No coke produced.
Illinois	5B	Washed	25.15	28.68	36.99	9.18	2.71	5000	42											No coke produced.
Illinois	5C	Washed	14.60	30.76	36.48	18.16	3.44	9000	42											No coke produced.
Indiana	1	Washed	16.53	36.38	40.05	7.04	2.03	8000	40	3473	368	5.71	1.18	80.52	12.59	1.69	.016	1.86	43.4	Fair coke, brittle.
Indian Ter.	1	Raw	10.29	31.46	44.39	13.86	1.34	8095	40											Burned to ash.
Indian Ter.	2	Raw	3.82	37.45	48.74	9.99	1.47	9000	66	5725	580	8.15	1.74	75.68	14.43	1.50	.050	1.88	63.6	Coke soft.
Indian Ter.	2	Washed	4.45	38.18	51.04	6.33	1.43	9000	65	4680	255	0.96	2.59	85.33	11.12	1.75	.043	1.84	52.0	Coke hard.
Indian Ter.	3	Raw	4.16	36.66	49.43	9.75	3.16	12000	65											Small coke and ash produced.
Indian Ter.	3	Washed	5.93	38.05	48.53	7.49	3.20	14000	66											Not improved.
Indian Ter.	5	Washed	16.95	33.30	41.61	8.14	2.90	10000	65											Small coke, fritted.

Iowa	1	Washed	12.84	35.91	41.00	10.25	4.61	9500	46	4828	572	10.53	1.65	70.39	17.45	3.89	.051	1.87	50.7	Very brittle.
Iowa	2	Washed	12.85	35.44	35.43	10.28	3.93	10000	64	3866	1153								3.87	Sintered.
Iowa	3	Washed	16.83	39.27	35.87	8.03	4.55	8000	43	3336	585	5.73	1.87	75.49	16.91	4.57	.0183	1.88	41.7	Fine fingered.
Iowa	4	Washed	17.80	37.59	37.39	7.14	3.59	8000	40	3722	426	13.05	2.32	73.10	11.53	2.97	.0123	1.82	46.5	Fine fingered.
Iowa	5	Washed	19.25	31.07	41.75	7.93	2.28	9000	66											Charred coke and ash produced.
Kansas	1	Raw	8.10	31.26	45.82	14.84	4.48	11300	120											No coke produced.
Kansas	2	Raw	3.96	30.46	45.54	20.04	5.59	9125	159											No coke produced.
Kansas	3	Raw	1.75	32.95	48.39	16.91	5.60	7100	96											Coked 12″ from top.
Kansas	4	Raw	6.63	36.99	43.45	12.93	7.19	10000	67	5213	432	0.52	1.68	79.82	17.98	6.15	.0148	1.92	52.1	Hard and brittle.
Kentucky	1	Raw	2.71	37.22	56.17	3.90	1.23	10000	66	5441	355	1.48	0.83	92.34	5.35	0.84	.034	1.83	54.4	Hard, fine fingered.
Kentucky	2	Raw	8.66	32.45	41.13	17.76	4.04	9000	42											No coke produced.
Kentucky	3	Washed	10.51	37.33	44.76	7.40	2.51	10000	66	5433	426	0.14	0.56	86.31	12.99	2.16	.009	1.81	54.3	Fair coke.
Kentucky	4	Washed	6.18	39.07	48.70	6.05	2.74	10000	66	5528	313	0.52	0.63	86.50	12.35	2.37	.015	1.84	55.3	Good color.
Missouri	2	Washed	14.14	35.53	42.57	7.76	3.24	12000	87	5040	580	3.45	1.80	80.27	14.48	2.79	.02	1.86	42.0	Long fingered.
Missouri	3	Washed	24.15	33.10	35.51	7.24	2.74	9000	41											No coke produced.
Missouri	4	Raw	12.04	41.35	41.34	5.27	5.14	11000	65	4905	128	2.51	1.11	85.57	10.81	4.60	.018	1.83	44.6	Fair coke.
West Virginia	1	Raw	1.93	36.50	54.97	6.60	0.88	9000	64	5572	268	0.40	1.95	87.47	10.18	0.71	.029	1.84	61.9	Good coke.
West Virginia	2	Raw	1.73	39.20	50.85	8.22	3.38	9000	50	5235	286	0.42	0.68	83.95	14.95	3.40	.023	1.94	58.2	Gray, brittle.
West Virginia	2	Washed	3.98	39.76	49.21	7.05	2.84	13000	64	7808	302	0.59	1.31	86.70	11.40	2.24	.017	1.89	60.1	Improved by washing.
West Virginia	3	Raw	2.25	30.60	57.40	9.75	0.99	9000	41	5929	364	0.22	0.83	80.77	18.18	0.93	.065	1.95	65.9	Gray coke.
West Virginia	3	Washed	4.11	29.54	57.34	9.01	1.18	14000	66	9070	535	0.38	0.87	84.48	14.27	1.19	.079	1.94	64.8	Not improved by washing.
West Virginia	4	Raw	2.72	27.62	59.16	10.50	0.86	12000	65	8907	428	0.62	1.43	86.10	11.85	0.82	.031	1.84	74.2	Good coke.
West Virginia	4	Washed	3.47	27.95	61.05	7.53	0.74	9000	42	6367	374	0.20	1.15	85.42	13.23	0.69	.019	1.94	70.7	Not improved by washing.
West Virginia	5	Raw	2.43	28.30	58.55	10.73	0.90	13000	64	8298	497	2.60	1.12	77.14	19.14	0.77	.067	1.90	63.8	Good coke; too much ash.
West Virginia	5	Washed	4.84	28.12	56.76	10.28	0.91	13000	66	7163	461	0.42	0.43	84.34	14.81	0.83	.086	1.89	55.1	Improved by washing.
West Virginia	5	Washed, fine	19.50	23.76	48.55	8.19	0.79	10000	69	4256	229	0.27	0.78	82.97	15.98	0.82	.087	1.89	42.5	Improved by washing; fine coal.
West Virginia	6A	Raw	1.76	21.48	71.92	4.84	0.55	13000	90	8303	381	2.83	2.17	89.84	5.16	0.69	.008	1.77	63.9	Gray, soft and light.
West Virginia	6B	Raw	2.27	22.03	70.30	5.40	0.88	9000	66	6399	382	0.36	1.34	93.04	5.24	0.76	.007	1.87	71.1	Better than A.
West Virginia	6C	Raw, fine	1.73	21.12	71.57	5.58	0.64	8000	44	5849	273	1.89	1.83	88.80	7.48	0.69	.006	1.79	73.1	Dense, tough.
West Virginia	7	Raw	3.85	20.55	70.58	5.02	1.36	8000	44	5119	287	0.67	1.23	90.40	7.70	1.03	.0061	1.80	64.0	Good coke.
West Virginia	8	Raw	3.82	31.77	57.21	7.20	0.89	9000	66	7124	589	2.79	0.53	82.37	14.31	0.77	.0116	1.92	79.2	Hard, good color.
West Virginia	9	Raw	3.81	31.08	57.04	8.07	0.83	8000	40	6084	314	0.29	2.41	88.15	9.15	0.82	.0094	1.84	76.0	Fair coke, heavy.
West Virginia	9	Washed	5.74	32.14	57.61	4.51	0.90	11000	66	6803	78	0.27	0.62	91.73	7.38	0.77	.012	1.87	61.8	Very good coke.
West Virginia	10	Raw	1.61	18.39	74.65	5.37	0.01	11000	63	7858	429	3.68	0.53	87.54	8.25	0.56	.007	1.89	71.4	Good coke.
West Virginia	11	Raw	3.35	15.94	68.76	9.95	0.47	11000	67											Burned to ash.
West Virginia	12	Raw	1.53	18.23	74.08	6.16	0.97	11000	68	7082	549	0.35	0.85	89.37	9.43	0.83	.0077	1.95	64.4	Fair coke.
West Virginia	12	Washed	8.36	18.20	68.54	4.90	1.11	8000	44	5050	583	5.16	0.72	86.57	7.55	1.01	.01	1.88	63.1	Large pieces.



THE UPPER PICTURE SHOWS THE EGGETTE MACHINE, MADE BY THE NATIONAL COMPRESSED FUEL CO.; THE LOWER, WM. JOHNSON & SONS' BRIQUETTING MACHINE.

and some both raw and washed. All coal charged into the ovens was first crushed in rolls to 1½ inches in size or smaller. There were altogether fifty-nine coking tests, for which only thirty-seven, or 63 per cent., produced coke of sufficiently good quality to sample for chemical analysis. One or two tests were made on non-coking coals with an added mixture of pitch or coal tar, with the result that a fair grade of coke was produced, encouraging some further investigations along these lines.

The results of the coking tests are summarized in the tables presented on the two pages preceding (*222* and *223*).

Briquetting Tests.—The equipment provided for carrying on the experiments relating to the briquetting of coals consisted of two machines of distinctly different types. One of these was furnished by William Johnson & Sons, of Leeds, England, of which the briquetting portion consisted of a double-compression, vertical-table press, with closed molds. It is designed for using stiff coal-tar pitch. The other briquetting machine was furnished as an exhibit by the National Compressed Fuel Company, of Chicago. It was built by the Chisholm, Boyd & White Company, on the Belgian pattern, in which the briquettes, or, more properly speaking, eggettes, were compressed in ovoid cups on the tores of narrow-faced rolls. As the rolls revolve, face to face, the excess material is squeezed out, the resulting pressure being dependent upon the viscosity of the mixture. The eggettes, which were something larger than a goose egg in size, weighed about three-tenths of a pound each. The capacity of each press was about 5 tons of eggettes or briquettes per hour, when running at full capacity. The briquettes from the English machine were rectangular and weighed from 5⅛ to 7¼ pounds, according to the character of the coal from which they were made. The American machine had the advantage of being adapted for the use of soft, or liquid, binding materials. The English machine, however, could only be used with stiff pitch, or similar material.

A large amount of experimental work was done on a laboratory scale with different binding materials, before they were tried on a commercial scale with the machines. The binding materials upon which this laboratory work was done consisted of pitch of various grades, creosote, asphalt (hard and soft, crude and refined), asphaltic pitch, petroleum (both of paraffine and asphalt basis), molasses, rosin, lime, and clay.

In the following table are given proximate analyses of the different pitches which are used in the briquetting of coals in the Eng-

lish machine. The letters, A, B, C, etc., are used to indicate the pitch used in the summary of briquetting tests, which is given later. All of the coal-tar pitches used were furnished by the Barrett Manufacturing Company, of St. Louis, or the Chatfield Manufacturing Company, of Carthage, Ohio. Pitches A, B, C, and D were supplied by the Barrett Manufacturing Company; E, F, G, and X, by the Chatfield Manufacturing Company. Pitch H was also furnished by the Barrett Manufacturing Company and was the product of the manufacture of gas from heavy petroleum:—

PROXIMATE ANALYSES OF PITCHES.

Pitch.	Laboratory No.	Moisture.	Volatile matter.	Fixed carbon.	Ash.	Sulphur.	Total.
A	1161	0.47	47.93	50.79	0.81	*0.80	100.80
B	1311	1.14	49.66	47.88	1.32	.70	100.70
C	1391	.88	62.75	35.84	.53	....	100.00
D	1465	1.45	54.05	43.91	.59	....	100.00
E	1464	1.02	54.11	44.04	.83	....	100.00
F	1457	.57	52.98	45.31	1.14	....	100.00
G	1453	.60	52.53	45.62	1.25	....	100.00
H	1555	1.04	61.44	36.72	.80	....	100.00
X	1125	.33	59.07	39.44	1.16	.88	101.38

Only the cheaper grades of rosin were used and they were found to be as good for this purpose as more refined material.

Asphaltic Binders.—The asphalts used in this experimental work were achieved from widely different localities. These binding materials are designated in the subsequent table as B1, B2, etc., from the following sources:—B1, California refined asphaltum, grade B. B2, rubbery asphalt product, manufactured by the Raven Mining Company, of Texas, known as "kopak" No. 30. B3, asphalt pitch, manufactured by the Standard Oil Company at one of its Texas plants. B4, crude asphalt from the Indian Territory. B5, a soft asphalt from the Gulf Refining Company, of Texas; and B6, soft asphalt, furnished by Mr. John McNeil, from Casper, Wyoming.

Petroleum Binders.—On account of the short time available for the experimental work that was necessary in the use of petroleum as a binding material, this work was limited to laboratory experiments. It was found that most of them were too fluid and had little or no binding qualities when used alone, and could only be satisfactorily used with rosin or hard pitch.

Briquettes Manufactured.—After the laboratory experiments had demonstrated that investigations were worth continuing on a commercial scale, the briquettes were made in quantities, on either the

* Approximately determined.

American or English machine, according to the tvpe of binder that had been used in the laboratory experiments. If the laboratory work showed that coals could not be briquetted except by using so much binding material that the increased cost was excessive, it was not considered advisable to continue the investigation on a larger scale. The number of "runs" made in the briquetting machines were twenty-seven. These were distributed as follows:—

One from Alabama, six from Arkansas, one from Colorado, two from Illinois, two from Indiana, three from Indian Territory, one from Iowa, one from Kansas, two from Kentucky, one from Missouri, one from Montana, two from New Mexico, one from North Dakota (lignite), one from Pennsylvania (anthracite culm), one from West Virginia, and one from Wyoming. There were four grades of coal which offered special opportunities for the application of briquetting processes. These were (1) the Pennsylvania anthracite culm, (2) the slack coal from the dry non-coking bituminous coal of the Mississippi Valley, and which is now either thrown on the slack pile and burned, or sold for practically nothing, (3) the fine coal produced in the mining of semi-anthracite coals of Arkansas and the Indian Territory, (4) the brown lignites. The experiments with the first three were generally highly successful, but little progress was made in the utilization by this means of the brown lignite coals. The high percentage of moisture contained therein, and the fact developed in the course of the investigation—that it was impossible to dry out this moisture without setting up the distillation of the lignite itself—has made it impossible with the means at hand to successfully briquette and improve the quality of this product. Enough has been done, however, to show that further investigations along these lines are highly desirable.

Experiments in the briquetting of coke breeze, and also that of anthracite culm, with a small percentage of bituminous coke, coal and pitch, have resulted very satisfactorily. It was also found that a fair degree of coke could be made of non-coking coals which had been mixed with pitch and then passed through the briquetting machines.

The results of the twenty-seven tests that were made on a commercial scale were as shown in the tables on pages 228 and 229. With their presentation this brief synopsis of the work done at the station during its first period of operation must close. The appropriation lately made by Congress for the continuation of the tests, it may be confidently expected, will enable much more and more valuable work to be done in the immediate future.

SUMMARY OF BRIQUETTING TESTS.

COAL						BINDER						BRIQUETTES			
		Chemical composition							Composition						
Name of sample	Character	Volatile matter	Fixed carbon	Moisture	Ash	Specific gravity	Per cent.	Kind	Volatile matter	Fixed carbon	Specific gravity	Weight in pounds	General character	Behavior on weathering	Behavior on burning	Crushing strength
Alabama No. 1		31.84	53.28	2.34	12.54		7	Pitch A	47.93	50.79		5.12	Good	Slightly disintegrates	Good	
							9.25	Pitch A								
Arkansas No. 1		17.46	66.69	3.24	12.61		11	Pitch X	59.07	39.44			Poor, friable	Disintegrates	Poor	
Arkansas No. 2		16.02	72.55	2.23	9.20		9.5	Pitch X				6.8	Poor, porous	Poor		
Arkansas No. 3	Slightly moist	19.47	66.71	2.19	11.63		8.7	Pitch A								
do	do												Very good, smooth & hard	Good	Held together until consumed	
Arkansas No. 4	Slack					1.35	12	Pitch X					Incoherent	Disintegrates		
do	do					1.35	10	Pitch A				6.47	Good compact	Good		
do	do					1.35	3	Rosin					Clean, compact		Some smoke	
							2	Pitch A				6.87	but brittle	Good	Very good	
do	do					1.35	3	Rosin							Burn readily	
do	do						3	Pitch A			1.13	6.87	Clean excellent	Good		
do	do					1.35	6	Pitch B	49.66	47.88	1.17	6.92	Excellent in every respect	No deterioration	No disintegration	8780
do	do	12.82	73.69	1.28	12.21	1.35	3	Rosin							No disintegration	17500
							2	Pitch B				7.20	Tender, friable			
Colorado No. 1		34.88	40.45	18.68	5.99		10	Pitch D	54.05	43.91		5.98	Hard and lustrous, but brittle	Slight deterioration	Satisfactory, little disintegration	
Illinois No. 1	Soft	37.48	39.57	9.75	13.20		16	Pitch X					Like pressed damp loam			
Illinois No. 4		31.90	43.55	12.91	11.64	1.34	6	Pitch D			1.16	6.95	Hard, but rather friable		Some disintegration	5100
do						1.34	8	Pitch D			1.11	6.43	Hard and tough	Good	Good	9327
do	Coarse					1.34	8	Pitch E	54.11	44.04	1.13	6.15	Not well pressed Somewhat porous		Fair	7266
do	Fine					1.34	8	Pitch E			1.03	6.50	Well pressed but friable	Fair	Fair	6000
do						1.34	9	Pitch E			1.08	6.43	Good	Fair	Good	9125
do						1.34	8	Pitch H			1.11	6.81	Clean. Excellent	Good	Very satisfactory	12810
do						1.34		Asphalt B4				6.77	Tough. Fair			
Indiana No. 1	Washed						7	Pitch D				6.80	Very good	Good	Very satisfactory	
Indiana No. 2		36.14	41.22	9.62	13.02		7	Pitch H				6.42	Clean, excellent	Good	Very satisfactory	

Ind. Ter. No. 2	Hard	36.15	48.40	4.45	11.00		13.4	Pitch X					6.15	Poor	Crumbled	Poor	
Ind. Ter. No. 3		37.00	47.25	4.61	11.14		8	Pitch A					6.56	Fair	Disintegrates	Fair	
Ind. Ter. No. 6	Dirty slack	31.28	41.40	8.03	19.29		7	Pitch D				1.205	7.35	Dense but crumbly	do	Disintegrates	5600
do	do						9	Pitch D					7.50	do do	do	do	
do	do						8	Pitch A						do do	do	do	
do	do						6	Rosin					7.00	do do	do	do	
							1	Lime									
do	do						6	Rosin				1.25	7.29	Strong, good		Good	6400
							1	Petroleum P3									
do	do						8	Pitch				1.215	7.25	Good, crumbles slightly		Good	6500
do	do						1¼	Creoso'									
do	do						8	Asphalt B5	80.75	19.25		1.22	7.12	Tough, good		Good	3200
do	do						8	Pitch H	61.44	36.72			7.27	Very good		Very good	
Iowa No. 4		35.59	39.37	14.08	10.96		7	Pitch E					6.73	Crumbled	Poor	Fair	
do							8	Pitch E					6.77	Strong	Good	Very good.	
Kansas No. 2		31.23	46.68	4.18	17.91		11	Pitch X						Poor	Poor	Poor	
Kentucky No. 1	Good coking	36.12	56.39	3.10	4.39		6	Pitch D					6.15	Good, slightly porous	Very good	Excellent	
Kentucky No. 2	Rather hard	37.94	45.02	7.91	9.13	1.37	9	Pitch E					6.83	Very hard	do	do	
do	Slack					1.37	8	Pitch E				1.13	6.83	Excellent	do	do	11300
Missouri No. 1	Washed	33.58	38.73	8.33	19.36		11.5	Pitch A						Pitch set too quick; porous	Fair	Good	
Montana No. 1	Washed	35.90	42.08	11.05	10.97		16	Pitch A					6.30	Fair, rather porous	Good	do	
do	do						7	Pitch B					7.00	Hard but brittle	do	do	
New Mex. No. 1		34.58	46.14	12.29	6.99		12	Pitch A						Very unsatisfactory	Crumbles	Disintegrates	
do							15.8	Pitch X						Poor	do	do	
do							8	Pitch D				1.13	6.83	Fair	do	do	7120
do							10	Pitch D				1.02	6.42	do do	do	do	5900
do							8	Pitch H				1.06	6.25	Hard and strong	Good	Good	13030
New Mex. No. 2	Slack	33.82	36.73	10.79	18.66		7	Pitch D					7.00	Crumbly	Disintegrates	Disintegrates	
do	do						9	Pitch D					7.12	Earthy	Fair	Fair	
N. Dak. No. 1	Tough. Not dry	29.50	25.68	35.38	9.35		10	Pitch A						Porous, little cohesion	Disintegrates	Disintegrates	
do	Dry						12	Pitch A						do	do	do	
Penn. No. 3	Anthracite culm	7.02	71.79	5.41	15.78	1.52	12.5	Pitch A 11 parts W. Va. coal					7.25	Hard and tough	Become pitted	Good, like anthracite	
do	do 84%					1.52	7	Pitch B									
do	do dried					1.52	9	W. Va. coal				1.174	7.64	Fair	do	do	4500
West Va. No. 6							7	Pitch B				1.28	7.40	Hard and strong	Good	do	17190
do							5	Pitch Y					6.12	do	Very good	Very good	
Wyoming No. 1		35.68	37.19	22.63	4.50		3	Pitch Y						Good	Good	Good	
do	Dried					1.16	9	Pitch H					6.31	Fair, porous	Fair	Sat'f'y	
							8	Pitch H				0.98	5.85	When cold hard	Good	Good	9600
do	do					1.16	5	Asphalt B6		78.77	20.75						
							2½	Rosin					5.40	Poor	Fair	Fell to pieces	
							1	Lime									
Arkansas No. 5		12.68	72.88	2.36	12.08			Pitch C									
Arkansas No. 6		13.80	38.50	3.80	13.81		8	Pitch A									

THE EFFECTS OF VACUUM ON STEAM-ENGINE ECONOMY.

By R. M. Neilson.

Mr. Neilson's two preceding articles dealt with, first, the means for the superheating of steam, and second, the influence of superheating on engine economy. The article now presented takes up the general aspects of the economy of condensing; a following one will discuss types of condensers and allied apparatus.—The Editors.

THE usefulness of a vacuum for a steam engine was known at a very early age. The Newcomen engine, which may be said to be the first engine to be usefully employed, was absolutely dependent on the existence of a vacuum. In fact, it has been asserted that the Newcomen engine should be called an atmospheric engine or a vacuum engine instead of a steam engine. Up till about 1840 the steam pressures used with condensing engines were usually so small that the reduction in back pressure due to condensing had a very great influence on the effective pressure on the piston. As higher steam pressures came into vogue, the absence of a condenser made less difference to the power of an engine; but it was recognized that condensing had the advantage of allowing a greater amount of useful work to be obtained from a given quantity of steam. It then became a serious question to consider in any case whether this gain was sufficient to pay for the condensing plant and the condensing water; and ever since then this question has demanded a consideration by steam-engine users.

In Figure 1 the area ACD denotes the work done by one pound of steam at a pressure of 200 pounds per square inch absolute, in expanding adiabatically to a pressure of 1½ pounds absolute, (which corresponds to a vacuum of about 27 inches of mercury, when the barometer is at 30 inches) and exhausting at this pressure. If the expansion had been carried only to a pressure of 15 pounds absolute, that is, just above normal atmospheric pressure, the work would be represented by the area ABE.

It is convenient in comparing the work done by steam in expanding to different pressures to consider, not only the work done by the steam when expanding, but also the work done when its pressure is usefully employed before it expands—that is, in the case of a piston engine, the work done before cut-off. We then get the

work actually obtainable from the steam when expanding to and exhausting at a given pressure. This work in the case of one pound of steam at 200 pounds absolute, expanding adiabatically to and exhausting at a pressure of 1½ pounds absolute, is represented by the area FACK and amounts to 244,000 foot pounds. The corresponding work when the expansion is carried only to 15 pounds absolute is represented by the area FABH and amounts to 146,000 foot pounds. This shows the enormous amount of additional heat energy converted into mechanical work when the steam is expanded from atmospheric to a very low pressure. This additional work would have been still greater if the expansion had been carried further. If, for example, the expansion had been carried to an absolute pressure of 0.6 pound, (which corresponds to a vacuum of 28.78 inches of mercury when the barometer is at 30 inches) the total work obtainable from the steam would have amounted to 278,000 foot pounds.

When the point B is reached on the expansion curve, 14.1 per cent. of the steam will have condensed; when the point C is reached, 22.6 per cent. of the steam will have condensed; and if the expansion curve were continued till the pressure was 0.6 pounds absolute, the amount of steam condensed would be 25.5 per cent. This of course refers to adiabatic expansion. Much more steam may be condensed if heat is given by the steam to the walls of the vessel in which the expansion takes place.

The actual advantage obtained in practice by condensing is not so great as is indicated in a diagram such as Figure 1. This is because the losses in a condensing engine are proportionately greater than in a non-condensing engine. That is to say, when the area ACD represents the

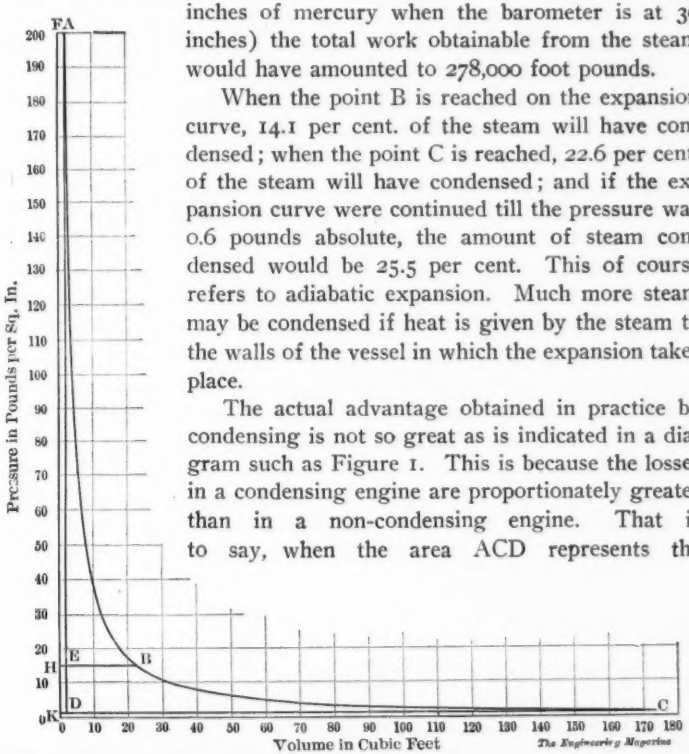


FIG. 1. DIAGRAM SHOWING THE WORK DONE BY STEAM EXPANDING ADIABATICALLY.

amount of work obtainable from an ideal engine, a smaller fraction of this is converted into useful work than when the area ABE represents the work obtainable from an ideal engine. This statement is true to a greater extent with reciprocating engines than with turbines. That is to say, condensing makes more difference in the economy of a turbine than in the economy of a reciprocating engine. This is for two reasons. In the first place it is not practicable for a reciprocating engine to expand to a very low pressure, such as to that given by a good condensing plant—the dimensions of the cylinder (the low-pressure cylinder, if a multiple-expansion engine) would be far too great; and, besides the excessive bulk, weight, and initial cost, the friction which the use of such a cylinder would involve would far more than outweigh the advantage gained by its use. For example, if steam at 200-pounds pressure absolute were expanded adiabatically to a pressure of 0.6 pounds absolute in a reciprocating engine, it would require a cylinder 6½-feet diameter and 12-feet stroke to deal with a single pound of steam per stroke. If the engine were a multiple-expansion one, these dimensions would represent the size of the low-pressure cylinder. A turbine, on the other hand, can without any practical difficulty and without the necessity of huge dimensions be made to expand the steam almost to the pressure in the condenser.

The other reason for the relatively greater gain of the turbine than the reciprocating engine by condensing results from the waste of steam in reciprocating engines through initial condensation and through leakage past valves. How much of the loss is to be attributed to initial condensation and how much to leakage past valves is a question about which there is much difference of opinion; but that a waste does occur is proved without doubt by the indicator diagram accounting for a much less weight of steam than is obtained by condensing and weighing the exhaust from the engine, and this when precautions have been taken to ensure that the steam enters the valve chest dry.

These causes prevent a reciprocating engine from benefiting from a good vacuum to the same extent as a turbine, or to anything like the extent to which it is thermodynamically entitled.

An objection to a high vacuum which acts equally against reciprocating and turbine engines is the lower temperature of the water in the hot well. If the water is pumped direct from the hot well into the boiler, then the hotter it is, the less coal will be required to generate steam. Although this objection acts equally against re-

ciprocating and turbine engines, the disadvantage with regard to the latter is almost insignificant in comparison with the benefits obtained from the increased expansion. The case is however different with the reciprocating engine, with which the question of temperature of feed water requires careful consideration. In cases where an economiser is employed in conjunction with a reciprocating engine and a boiler, and where there is always ample heat in the waste gases from the boiler to heat the feed water, the reduction of the temperature of the hot well becomes unimportant.

It is generally admitted that the vacuum which is most beneficial to a reciprocating engine is about 24 to 26 inches of mercury when the barometer is at 30 inches; with a better vacuum the additional gains are eaten up by the additional losses. Of course, the exact figure in the case of any engine depends on the size and type of engine, the conditions under which it is worked, the nature of the condensing plant, the temperature of the cooling water, etc.

It has been asserted by Mr. Alfred Saxon* that a reciprocating engine, when working at full load, can benefit by a better vacuum than when working at light load. This seems reasonable, as the additional gains due to increase of vacuum will be less per revolution of the engine at light load than at full load, while the additional losses due to the same will be practically the same at both loads. The point where the gains just equal the losses will therefore occur at a poorer vacuum at light load than at full load. This would seem to show that when a condensing engine is run with a widely varying load with a regular diurnal period, and when a cooling tank is employed to allow the same condensing water to be used over and over again, it would be advantageous in many cases to run the engine non-condensing at light loads in order to allow the water to cool and thus have it in better condition for producing a fairly good vacuum when the engine is running at full load.

Steam turbines are usually chosen for use in power stations on account of their economy when run condensing. When deciding whether to install turbine or reciprocating engines in a power station, it is therefore important to make certain that a cheap and plentiful supply of condensing water will be available not only at the time of the installation of the plant, but at all future times as far as can be foreseen.

Turbines benefit very much by condensing. Condensing steam turbines have a very much lower steam consumption than non-con-

* Manchester Association of Engineers, Nov. 28, 1903.

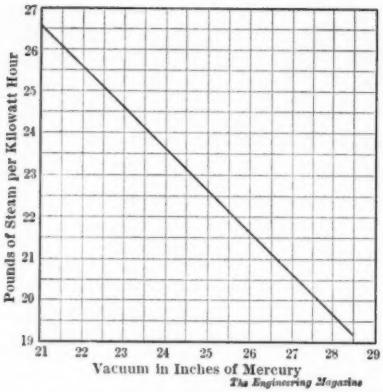


FIG. 2. STEAM CONSUMPTION IN POUNDS PER KILOWATT HOUR OF A 600-KILOWATT CURTIS STEAM TURBINE AT FULL LOAD WITH VARYING VACUUM.

densing steam turbines of the same type and power and supplied with steam at the same temperature and pressure. A steam turbine which with a good vacuum has a higher efficiency than a reciprocating engine working at the vacuum which suits it best, may make a very poor show compared with the reciprocating engine when both are working non-condensing. A turbine wants the best vacuum it can get; and an increase of vacuum from 27 inches of mercury to 29 inches when the barometer is at 30 inches should very considerably reduce the steam consumption.

Tables I and II and Figures 2 and 3 show the effect of vacuum on the steam consumption of steam turbines.

Table I has reference to a turbine built by Messrs. C. A. Parsons & Co. of Newcastle-on-Tyne.

It will be seen that in this test every aditional inch of vacuum has reduced the steam consumption by about 4 per cent. (rather more than one-quarter load).

TABLE I. STEAM CONSUMPTION OF 500-KILOWATT PARSONS TURBO-ALTERNATOR RUNNING AT 2,500 REVOLUTIONS WITH 140 LBS. STEAM PRESSURE AT THE STOP VALVE AND NO SUPERHEAT. (BASED ON RESULTS OF TESTS.)

Vacuum constant from full load to no load. Inches of mercury.	Consumption of steam per kilowatt hour. Full load.	Half load.	Quarter load.	Consumption per hour. No load.
29	....	....	....	1500
28	22.2	25.6	32.4	1700
27	23.1	26.9	34.5	1900
26	24.0	28.2	36.6	2100
25	25.1	29.7	39.0	2300
24	26.2	31.2	41.2	2500
23	27.5	32.9	44.8	2700
22	28.9	34.7	46.3	2900

Table II refers to a 1,500-kilowatt turbine built by the Westinghouse Machine Company.

It will be seen that an increase of 1¼ inches of vacuum (allowing for the difference in the barometer) reduces the steam consumption nearly 8 per cent. (The slight increase in the superheat of the steam in the second test will do more than compensate for the reduction in the load.)

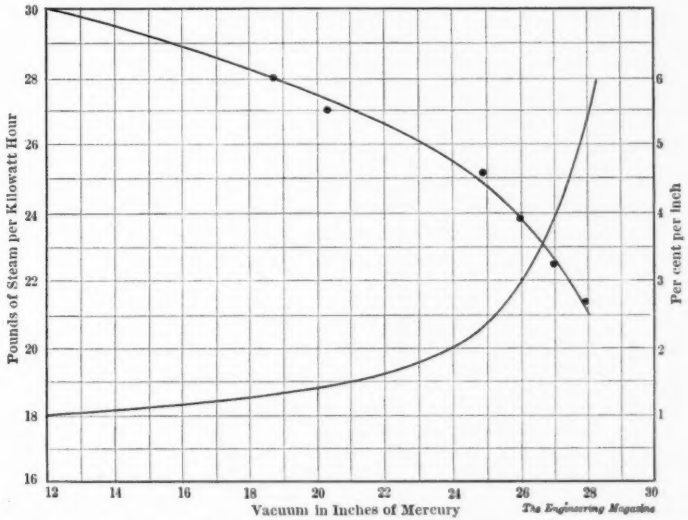


FIG. 3. EFFECT OF CHANGE OF VACUUM ON THE EFFICIENCY OF A PARSONS TURBINE.

TABLE II. TESTS OF 1,500-KILOWATT WESTINGHOUSE-PARSONS TURBO-GENERATOR AT HARTFORD, CONN., U. S. A.*

Average load in kilowatts.	Length of test in hours.	Steam-gauge press. in lbs. per sq. in.	Superheat degrees F. (mean).	Barometer in inches of mercury.	Vacuum in in. of mercury.	Steam consumption. Lbs. per kilowatt hour.
888	6	152.6	32.9	30.04	25.83	26.53
834	6	153.2	35.4	30.26	27.26	24.60

Figure 3 illustrates well how the efficiency of a turbine of the Parsons type is affected by change in degree of vacuum. The curve which is concave downwards shows the consumption of steam per kilowatt hour with different degrees of vacuum. The dots represent the measured consumptions from which the curve was drawn. The other curve shows the percentage increase of efficiency or reduction of steam consumption per inch of increase of vacuum at different

* The Steam Turbine, by R. M. Neilson. Longmans & Co.

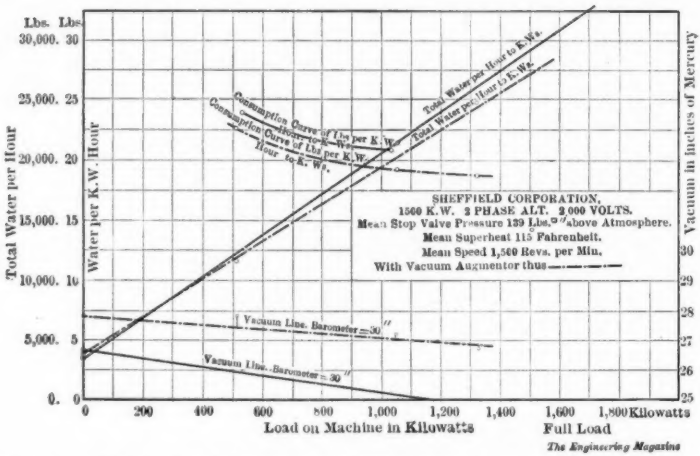


FIG. 3 A. SHOWING THE EFFECT OF A PARSONS VACUUM AUGMENTOR IN IMPROVING THE VACUUM AND REDUCING THE STEAM CONSUMPTION OF A STEAM TURBINE.

vacua.* Large Parsons turbines seem to benefit rather more than small ones from an improvement in the vacuum.

Figure 2 shows how a change in the degree of vacuum affects the efficiency of a Curtis steam turbine. The line of steam consumption per kilowatt hour with varying vacuum is almost straight; and tests of other Curtis turbines have given a line of equal straightness. Each additional inch of vacuum between 21 inches and 24 inches reduces the steam consumption about 4 per cent., and every additional inch between 26 and 29 reduces the steam consumption about 5 or 6 per cent. Figure 3A shows the effect of increased vacuum on a steam turbine; but the chain-line curves which indicate the steam consumption with the higher vacuum include the steam consumption of an augmentor used to improve the vacuum, as will be described later. Ignoring the means employed to obtain the vacuum, the turbine therefore in this case gains more by increase of vacuum, especially at light loads, than is evident from the figure.

Of course, if a turbine is to benefit by having a good vacuum in the condenser, we must see that the exhaust steam from the turbine has an easy passage to the condenser; and as with a good vacuum we are dealing with very large volumes and very low pressures, we must have the exhaust pipe of large sectional area and as short as possible. This is done in practice as far as practicable. The exhaust

* Paper read by William Chilton before the Manchester Section of the Institution of Electrical Engineers, Feb. 2, 1904.

pipes of condensing steam turbines are usually of a sectional area very much in excess of that which is usual with condensing reciprocating engines. For example, the exhaust pipe of the Parsons 1,000-kilowatt steam turbine at the Close Works of the Newcastle and District Electric Lighting Company is 3 feet in diameter.

In order that the exhaust pipe may be as short as possible, it is common and good practice with large steam turbines where gound space is of great value (as it usually is in power stations in large cities) to place the condenser in a basement below the exhaust end of the turbine. Of course, when ground space can be afforded on the engine room floor, it is better to place the condenser alongside the engine where it can more easily be got at. The condenser and pumps usually require much more attention than the turbine.

Although a reciprocating engine does not benefit to the same extent as a turbine by having a very good vacuum, there is nevertheless usually a very great economy to be effected by employing condensing plant. A good non-condensing reciprocating engine will usually, if provided with a condenser maintaining a vacuum of 25 inches of mercury, have its steam consumption per indicated horse power per hour reduced at least 20 per cent.; and many non-condensing engines now in use employing low-pressure steam could have a much greater reduction effected by the employment of condensing.

Besides the reduction in steam consumption brought about by condensation, we have in many cases to allow for a reduction in the coal consumed for a given amount of steam generated, owing to feed water being obtainable from the hot well at a higher temperature than feed water could be obtained if a non-condensing engine were used. On the other hand, the fact must be taken into account that the water in the hot well is usually greasy owing to the mixture with the the water of lubricating oil. This oil has to be removed from the feed water; otherwise the boiler heating surface soon becomes ineffective through getting a deposit of grease, and the boiler may even be rendered dangerous from this cause. Usually the oil is removed from the water by oil filters or separators. Sometimes the oil is sought to be removed from the exhaust steam before this enters the condenser, and sometimes both methods are employed at the same time. These oil separators are troublesome, and generally speaking are a long way from being entirely satisfactory. The steam turbine scores a decided advantage over the reciprocating engine in having no oil in its exhaust steam.

AN ANALYSIS OF CENTRAL-STATION OPERATING COSTS AND REVENUE.

By H. S. Knowlton.

IN the recently published Twentieth Annual Report of the Massachusetts Board of Gas and Electric-Light Commissioners, covering the year ending June 30, 1904, appears a vast amount of interesting data, in bulk, upon the business of artificial illumination as conducted in that State. Returns are included from twenty-six companies supplying both gas and electric light, and from sixty-eight furnishing electricity only. There are also included the reports of twenty-one municipal plants, four of which do a combined gas and electric-lighting business, the other seventeen devoting themselves to electrical supply alone. Interesting and important as these total figures deservedly are, there are many significant points which are suggestive only when exhibited on a unit basis.

The analysis of the income and expenses of all the central stations in the State shows that the gross earnings of the companies for the year ending June 30, 1904, amounted to $7,663,961.52. Over $3,125,000 of this was earned by the Edison Electric Illuminating Co. of Boston alone. In order to get a concrete idea of the distribution of the receipts and expenses in the central stations of the State as a whole, we may resort to a tabulation of these accounts on the basis of $1.00 as a unit, following the general method of analysis sometimes used in apportioning a street-railway five-cent fare.

Each dollar earned by the central stations of Massachusetts, then, for the year under consideration, was made as follows:—

INCOME.

From sale of commercial arc lights by contract	$ .029
" " " " incandescent lights by contract	.049
" " " " arc and incandescent lamps by meter	.508
" " " public arc lights	.192
" " " " incandescent lights	.051
" " " electric power	.157
" " " current to other companies	.007
" rent " motors	.001
" " " fixtures	.001
" " " meters	.001
" steam heating	.004
Total	$1.000

These figures are much more significant to the engineer than the totals from which they were derived. It is at once evident that the bulk of central-station business—83 per cent., in fact—consists of commercial lighting on meter and contract rates. A striking feature is the small proportion represented by the earnings from the sale of power—less than 16 per cent. While this does not by any means indicate the relative volume of lighting and power-energy output, since the power rates are presumably lower than the lighting charges, it is evident that there is room for working up a much larger motor business. The tabulation of motor horse power connected, in the report itself, shows this, as there are but seven companies having 1,000 horse power or over in motors wired to their circuits. These are as follows:—

Edison Electric Illuminating Co., Boston	24,150	horse power.
Lowell Electric Light Corporation	3,504	" "
United Electric Light Co., Springfield	2,306	" "
Haverhill Electric Co.	1,720	" "
Cambridge Electric Light Co.	1,525	" "
Lynn Gas and Electric Co.	1,400	" "
Worcester Electric Light Co.	1,073	" "

The expenses of the central stations of Massachusetts, on the basis of payment from each dollar earned, were as follows:—

EXPENSES

Coal and other fuel	$.145
Rent of real estate used for plant	.012
Oil and waste	.005
Water	.006
Wages at station	.073
Station repairs	.006
Steam-plant repairs	.015
Electric-plant repairs	.014
Apparatus and machinery	.006
Wages for care of lights and meters, clerical labor in this department, and salary or commission of collectors	.030
Repairs and renewals of lines, meters, lamps, and motors	.063
Distribution tools and appliances	.006
Carbons	.009
Incandescent lamps	.022
Globes	.001
Directors' allowances	.001
Salaries of officers	.024
General salaries	.032
Rent of offices, if separate from plant	.003
General office expenses	.022
Taxes	.068
Insurance	.014
Law expenses	.007
Claims	.001
Bad debts	.005
Incidental expenses	.001
Current bought	.009
Total	$.600

The peculiar distribution of the operating expenses among a large number of small items, relatively speaking, is at once evident from the foregoing tabulation. The comparatively small part played by salaries and wages in the total expense budget is noteworthy—a strong contrast to the condition obtaining in electric-railway circles. The largest single item of expense is the fuel account, followed at a considerable distance by wages at stations, taxes, and repairs and renewals of the distributing system. Singularly enough, the cost of renewing incandescent lamps equals the general office expenses.

Following out the partitioning of the dollar of gross income a little further in the report, we have:—interest $0.055; dividends, $0.201; and depreciation, $0.026. Presumably, interest is computed upon the total investment at the beginning of the year at the rate paid upon the bonds or notes, and depreciation at the rate of 5 per cent. upon the cost of the plant as shown by the books at the beginning of the year. In taxes, six companies paid at the rate of over $10,000 a year, ranging from the Boston Edison's $312,000 and slightly over to Lynn's $10,231.

Among the larger cities of the State, underground-conduit construction has been increasingly adopted, so that in this class, Worcester exceeds every other city of prominence in the ratio of underground to the total length of wire in service. Worcester has 46 per cent. of its wire mileage underground—a total of 392 miles. The Boston Edison follows with 41 per cent. and a total of 1,292 miles below the surface of the streets. Springfield, Lowell, Fall River, Brookline and New Bedford are likewise running up promising totals.

The gross earnings per ton of coal burned are interesting, in the different cities of prominence. To an extent at least, it is an index of the operating efficiency of the whole system, given fuel of the same heating power per ton. Taking those cities burning over 4,000 tons of coal per annum, and excluding those which use water power or burn any considerable amount of coke or screenings, we have:—

GROSS EARNINGS PER TON OF COAL BURNED.

Edison Electric Illuminating Co., Boston	$48.50
Worcester Electric Light Co	40.20
Cambridge Electric Light Co	26.60
Lowell Electric Light Corp	25.50
Fall River Electric Light Co	25.00
Waltham Gas Light Co	24.70
Edison Electric Illuminating Co., Brockton	22.80
Chelsea Gas Light Co	18.80
Hyde Park Electric Light Co	13.80
Pittsfield Electric Co	13.60

It must be borne in mind that the above comparisons are limited,

since the quality of coal burned and other factors cannot be assumed to be identical in any two different places. At the same time the upper figures of the table are worth striving to attain. If a plant burns many tons of inferior coal, it cannot of course reach the figures of return in gross earnings per unit of fuel consumed which are so notable in the cases of Boston and Worcester.

Gross earnings per capita for a given installation are often interesting to the engineer who is called upon to estimate upon different electric-lighting propositions, as well as to the station manager, himself. In the following table these data for Massachusetts cities of 15,000 and over are given, together with a statement of the ratio of operating expenses to gross earnings and dividends paid:—

GROSS EARNINGS PER CAPITA, POPULATION, ETC. (15,000 OR OVER)
ELECTRIC LIGHT COMPANIES.

Company.	Population Served.	Gross Earnings per Capita.	Operat'g Ratio.	Per Cent. Dividends
Edison (Boston)	630,000 (approx.)	$4.95	.52	10
Worcester E. L.....	118,421	2.46	.52	8
Lowell E. L.....	105,411	2.21	.61	8
Fall River E. L.....	104,863	1.98	.63	7
Cambridge E. L.....	95,815	2.35	.57	6
Malden E. L.....	89,206	2.15	.71	8
Lawrence G.	81,127	1.84	.65	..
Lynn G. and E.....	79,297	2.87	.68	..
United (Springfield)	69,975	4.35	.56	8
New Bedford G. and E....	66,009	1.85	.53	..
Newton and Watertown G.	43,293	2.24	.92	..
Charlestown G. and E....	40,652	1.37	.74	..
Edison (Brockton)	40,063	2.76	.57	5
Haverhill E.	39,551	2.20	.73	8
Brookline G. L.....	39,214	4.98	.51	..
Salem E. L.....	35,956	3.40	.69	..
Chelsea G. L.....	34,072	2.55	.62	..
Fitchburg G. and E.....	31,531	2.38	.70	..
Gloucester E.	30,713	1.98	.69	7
Woburn L., H. and P.....	27,699	2.50	.86	..
Pittsfield E.	24,780	4.67	.86	8
No. Adams G.....	24,200	3.63	.79	..
Quincy E. L. and P.....	23,899	2.50	.60	5
Waltham G. L.....	23,481	4.28	.69	..
Northampton E. L.....	18,643	2.55	.58	8
Central Mass. (Palmer)...	17,068	2.70	.55	..
Suburban (Revere)	16,453	5.00	.60	..
Marlboro E.	15,530	1.92	.82	..

Probably the most noteworthy feature of these figures is the variation in them, in different cities. There would seem to be room for the increasing of central-station business in many of the cities tabulated, as well as decreasing the cost of operation. Although variable local conditions preclude the drawing of any very definite comparisons between the different cities, there is no gainsaying the fact that a high average of gross earnings per capita means that the company is at

least endeavoring to extend its business to the saturation point of the community which it serves. Generally speaking, when the ratio of expenses to gross earnings continues to stand in the upper register, it is time to look around the power station for obsolete equipment and wasteful methods of operation.

It is manifestly impossible to draw from the foregoing tabulation any conclusions in regard to the relations existing between population and gross earnings per capita. The number of cities of each group of approximately equal population is too small for the determination of anything like a fair average. If the table does nothing else, it illustrates how widely conditions vary, even between the cities of a single commonwealth. Useful as it is to know what are the gross earnings per capita of an electric-light company in existing cities, it is apparent that the same figures cannot be applied to other cities of approximately equal size without knowing something of those cities along general economic lines. That electric lighting as a business is still in a transition stage is evident from a study of these data, and other figures in the report itself. The wide discrepancies between the different companies' showings prove beyond question that there is room for the practice of expert engineering in bringing a higher standard of efficiency to the front. In the light of modern scientific progress, there would seem to be no need of such tremendous differences in the cost of generating, distributing, and selling electricity for power and lighting in communities less than two-hundred miles apart.

In conclusion, nothing in the foregoing paragraphs is intended to belittle any quantity met in the central-station business as too small for attention on the part of the manager desiring to keep receipts up and expenses down. The analysis of the income and expenditures of the various companies on the basis of each dollar earned was made for the purpose of comparison—to enable the proportions and relations between the different items to be quickly realized. Thus, oil and waste amount to but half of one per cent. of the total cost of operation; but in toto the cost of these items amounted to nearly $4,000 during the year. Evidently, then, it is worth while for any central-station man to cut a quarter, or even a sixteenth, of a cent from his operating expenses in each of the dollars which make up the oil-and-waste account, and the same reasoning applies to practically every other detail of station and distribution service. If any manager or engineer finds food for thought in this all-too-brief anaylsis of a few of the striking features of central-station practice in Massachusetts, the object of the writer will be attained.

COST KEEPING ON GENERAL CONTRACT WORK.

By A. W. Buel.

II. THE WORKING SYSTEMS OF SEVERAL SUCCESSFUL CONTRACTORS.

Mr. Buel's first paper (published in our April issue) pointed out the commercial value of prompt and accurate figures of costs. The one now presented describes several plans in actual use, for thus finding and recording costs. A following article will propose an extension of cost-keeping methods on contract work by the use of the best available modern facilities.—THE EDITORS.

THIS outline of several systems of cost keeping, illustrating the practice of successful contractors, has not been attempted without some hesitation. A complete presentation, in greater detail, might be more satisfactory; but sufficient data have not been obtainable. It remains for those who have devised or are using modern methods to write up full descriptions. Anyone who expects to find a system already in use that he can copy exactly and transplant to his own business, under different conditions and personnel, is likely to be disappointed. After all, very simple and imperfect descriptions often give rise to important suggestions, and not infrequently in unforeseen directions. Such a result, in the present case, will be very satisfactory to the writer.

The Terry and Tench Company of New York are engaged almost exclusively in the erection of structural steel, in which line they have broken several records, both in time and cost. Erection records are not broken nowadays without good management and an efficient organization. Directness in all operations is also essential, and this feature is in evidence in their system of keeping labor accounts.

Form A shows two pages from their weekly time books. Each man's total time in hours is entered in the column for the day, opposite his name. and his total time for the week, the rate, and total amount earned are carried out in their respective columns. Under each name the distribution is entered on separate lines for each class of work and each contract, the totals of the time and amounts in the distribution balancing with the total time and amounts opposite the man's name. The amounts for each class of work and for each contract for the week, are then collected and added as shown on Form B. The totals of Form B are entered each week on Form C, and when

TIME, Week ending Saturday, October 7th 1903

8 Hours per day

NAMES.	M	T	W	T	F	S	Total Time	Rate per day.	AMOUNT $	AMOUNT Cts.
H Smith #1	8	8	6	8	8	8	46	4.50	24	19
Contr. 200. Sat'y Iron	8	8					16		9	00
" Mfg & Rpg Tools			6				6		3	38
" 225 " "				5			5		2	81
" " Setty Iron					8	8	16		9	00
W. Brown #2	8	8	4	8	6	8	42	4.50	23	63
Contr. 200 Setty Iron	8	8					16		9	00
" Mfg & Rpg Tools			4				4		2	25
" 225 " "				8			8		4	50
" " Setty Iron					6	8	14		7	88
Geo. Alligood #3	8	8	4	8	8	8	44	4.50	24	75
Contr 200 Setty Iron	8	8	4				20		11	25
" 225 " "				8	8	8	24		13	50
Brutus Johnson #4	8	8	4	8	6	8	42	4.50	23	63
Contr. 200. Setty Iron	8						8		4	50
" Bolting		8	4				12		6	75
" Plumbing				8	6	8	22		12	38

TIME, Week ending Saturday, October 7 1903

NAMES.	M	T	W	T	F	S	Total Time	Rate per day.	AMOUNT $	AMOUNT Cts.
Theo Skinner #5	8	8	4	8	8	8	44	4.50	24	75
Contr 200 Rivit-	8	8	4	8	8	8				
Wm Robinson #6	8	8	4	8	8	8	44	4.50	24	75
Contr 200 Same										
Fred Jackson #7	8	8	4	8	8	8	44	4.50	24	75
Contr 200. Same										
C. Murphy #8 (Heater)	8	8	4	8	8	7	43	4.50	24	19
Contr. 200. Same										
T. Bruce. #9		7	4	8	8	8	35	4.50	19	69
Contr 200 Setty Iron		7	4				11		6	19
" 225 " "				8	8	8	24		13	50
H. Abrahams #10		7	4	8	8	8	35	4.50	19	69
Contr 200. Setty Iron		7	4				11		6	19
" 225 " "				8	8	8	24		13	50
T Burns #11										
Contr 200. Watch	1	1	1	1	1	1	7		12	00

FORM A. TWO PAGES FROM DAILY TIME BOOK, TERRY & TENCH CO.

As entered here, the week is kept in the usual way from Monday to Saturday. In point of fact, the firm's time books have the day letters charged so as to keep a week from Thursday to Wednesday.

FORM B. TERRY & TENCH CO.
[Modified for Engineering Magazine]
DISTRIBUTION, WEEK ENDING OCTOBER 7TH 1903

No	Totals.	Setting Iron.	Making & Repairing Tools.	Bolting.	Plumbing	Riveting	Watchman	Totals.
		CONTRACT 200						
1.	24 19	9 00	3 38					
2.	23 63	7 00	2 25					
3.	24 75	11 25						
4.	23 63	4 50		6 75	12 38			
5.	24 75					24 75		
6.	24 75					24 75		
7.	24 75					24 75		
8.	24 19					24 19		
9.	19 69	6 19						
10.	19 69	6 19						
11.	12 00						12 00	
Totals	246 02	46 13	5 63	6 75	12 38	98 44	12 00	181 33
		CONTRACT 225						
1.		9 00	2 81					
2.		7 88	4 50					
3.		13 50						
4.								
5.								
6.								
7								
8.								
9.		13 50						
10		13 50						
11.								
Totals		57 38	7 31					64 69
								246 02

Summary

Charge Contract 200	181 33	C/R Fol.	41
" " 225	64 69	C/R Fol.	60
Ex Pay Roll &c.	246 02	C/R Fol.	110

FORM B. TERRY & TENCH CO. DISTRIBUTION OF WEEK'S WAGES.

a job is finished, the columns of this last form are added up, giving the total cost of labor on the contract and the total of each class.

With the record of the number of tons of iron set, riveted, etc., each week, which is not difficult to keep, the cost per ton for each part of the work can be obtained in a few minutes. All of this information is available on the day following the close of the weekly time roll, or Thursday of each week. Should it then appear, for

Job 1 Contract 200 Tools																							
1903 Week Ending	Setting		Drivers		Bolting		Plumbing		Riveting		Watch		Gen. Lab.								Total	
Oct 7	46	13	5	63	6	75	12	38	98	44			12								181	33
" 14	51	25	10	15	10	25	8	00	99	25			12								191	
" 21	65	95	12	02	8	40	12	50	101	25			12								212	12
" 28	78	25	5	75	9	20	14	25	68	50			12		49	00					232	08
Chan Total	241	58	32	68	34	70	43	13	367	44			48	00	48	00					816	53
Job 2 Contract 225																						
Oct	Foreman		Apprentice		Setting		Bolting															
" 7	7	31			57	38															64	69
" 14																						
" 21																						
" 28																						

The Engineering Magazine

FORM C. TERRY & TENCH CO. TOTAL DISTRIBUTION OF LABOR ON A CONTRACT.

instance, that the riveting or setting of iron on a contract has cost more that the estimate, or more than it should have cost, the superintendent's attention is immediately directed to the fact, with the result that the efficiency of the labor is improved or a good and sufficient reason for the increased cost is recorded. Where several gangs, bosses, and foremen are working on the same or comparable work, this system will show which are the most efficient, and "natural selection" will take care of those who fall below established standards.

This system is simple and gives quick results in very satisfactory detail. Any competent time keeper can handle it, and without any additional expense. It is particularly adapted to a business where the number of accounts in the distribution is not large, and for a relatively small force. Where a large number of men, say over two hundred, are employed in one locality, the form of the time books could be changed to advantage. Other variations will no doubt occur to any one in adapting it to the requirements of his particular business.

The method employed by the Mason and Hoge Company (incorporated) and T. H. Riddle Construction Company, is applicable to large and diversified works. It is understood to have given satisfactory results on their contract for Lock and Dam No. 10, Kentucky River. The time keeper goes over the work twice a day and enters the time of the men in a time book, which has no special features requiring description. Each foreman also records the time of his men on daily report sheets (D), and gives the detailed classification and amount of work done in the space under "Remarks—Work Done." The location and type of work are given at the head of the sheet.

MASON & HOGE CO.

FOREMAN'S DAILY REPORT.

Date .....

Location .....

.....

Type of Work .....

FORCE ACC'T

Name.	Hrs.

REMARKS.
Work Done.

Erecting Concrete Mixer. 6 hours foreman and labor.

Mixing Concrete, 4 hours each.

To batches, of 1½ yards each mixed = 45 yards.

SUMMARY.

Foreman	
Engineers	
Carpenters	
Laborers	
Teams	

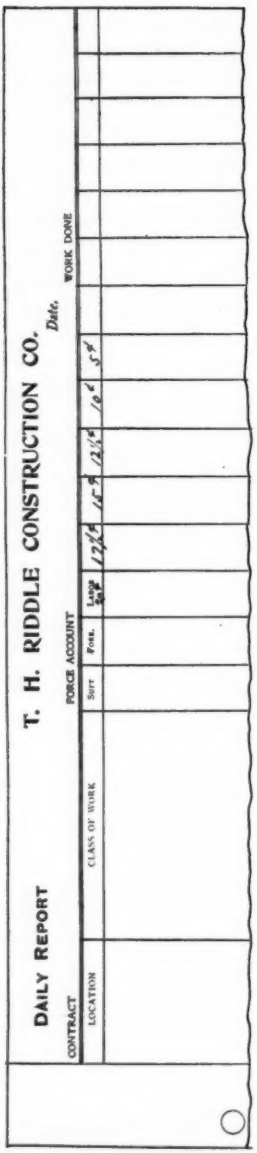
Foreman .....

FORM D. FOREMAN'S REPORT.

These report sheets are turned in to the time keeper at the end of each day, and he checks his time book with the foreman's reports and enters up the classification. This makes a good check on the time of the men, and has been found advantageous in cases of dispute on pay day. If the detailed classification could be given in tabulated form instead of in general notes in the space under Remarks, it would no doubt be clearer and more accurate. The average foreman is not likely to be over-concise and clear in written notes, and the time keeper is likely to have some trouble until he becomes familiar with them. All data of any importance, except such as are concerned with irregularities, should be, as far as possible, eliminated from the remarks column.

The basis of the system seems to be that the gang, foreman and men, reported on one sheet, Form D, constitute a working unit, and the classification and distribution of time is the same for all the names on the sheet. In many cases such a condition cannot be maintained, and no specific provision being made for correctly recording irregularities in the distribution of the time of members of the unit, the resulting distribution of costs can only be approximate, with an indeterminate error.

The summaries of all the foremen's reports for the day are then

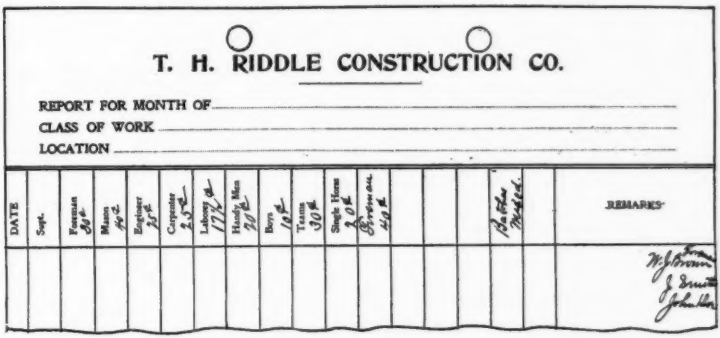


FORM E. DAILY REPORT SHEET.

entered on a Daily Report Sheet, Form E, one line on the latter being used for each foreman. The amount of work done of each class is entered in the columns on the right-hand side of the sheet. When a foreman and his men have had only one class of work for the day, the unit cost of labor can be readily extended on this sheet. It is not clear how this can be easily or accurately done when more than one class of work is reported by the same foreman, unless a separate line is used for each class and each foreman's report, which would require no extra expenditure except for paper. In any case the degree of accuracy will remain that of the gang-working-unit system, which is an unknown and variable quantity.

The daily report sheets, Form E, are made out for the use of the superintendent, and if each morning he has on his desk the report for the previous day, with unit costs extended as indicated above, he should find it of great assistance in economical administration. Much time and labor in extending unit costs can be saved by the use of a slide rule, which gives results with an accuracy of a fraction of one per cent. These reports are transmitted to the main office and filed.

The Monthly Report Sheet, Form F, quoting from the explanation of the system furnished by Mr. Richard Lahey, "is made up from either sheets D or E, preferably from D, and a separate sheet is used for each sub-division of the work. Thus concreting may have eleven sheets viz., 1 quarrying; 2, hauling stone; 3, crushing stone; 4, haul-



T. H. RIDDLE CONSTRUCTION CO.

REPORT FOR MONTH OF _____

CLASS OF WORK _____

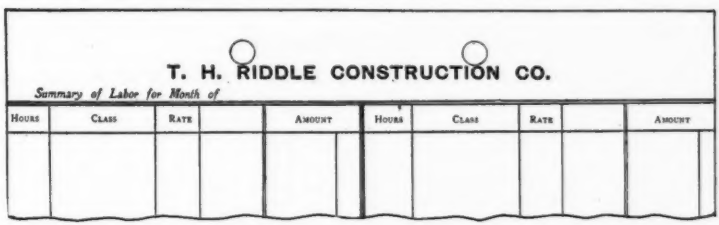
LOCATION _____

DATE	Supt.	Foreman	Mason	Engineer	Carpenter	Laborg.	Handy Man	Boys	Teams	Single Horse	Broken.				Pd. for Material		REMARKS

FORM F. MONTHLY REPORT SHEET.

ing sand; 5, hauling cement; 6, mixing concrete; 7, hauling concrete; 8, placing concrete; 9, building forms; 10, erecting crusher; 11, repairs to crusher. The object is to get the cost of erection and repairs separately, and also, as far as possible, that of all the other items. On these sheets are entered the hours and rates and the work done. For convenience in reference, the name of the foreman making the report is entered in the Remarks column. The time of the office force is also tabulated and distributed. At the end of each month these sheets are footed, and the unit costs worked out."

The summary of all the monthy report sheets, F, for each month, is made out on sheet G, and this must balance with the monthly pay roll. Materials and supplies are required to be accompanied on delivery by an invoice, on which the articles are checked off as received and the distribution noted, as "charge to account of repairs to crusher," or "charge to account of concrete forms for * * * * ," etc. These are then entered and distributed on their proper sheets.



T. H. RIDDLE CONSTRUCTION CO.

Summary of Labor for Month of

Hours	Class	Rate		Amount	Hours	Class	Rate		Amount

FORM G. SUMMARY OF MONTHLY REPORTS.

Purchases for "account of plant" are charged to the work or subdivision on which they are first used, and when afterwards used on other work or on another sub-division, the first is given a credit. If

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COST OF WORK ON

Date 1902		Excavating		Shoring		Concrete		Rubble Stone		Common Brick		Face Brick		Enamel Brick	
		Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material
Estimate Aug	20	2300	200	600	300	3000	9000	1600	4000	6000	7000	3400	6000	2500	8000
October	31	2000	175	550	250	1560	6800	800	2000	600	780				
Nov.	30					990	2000	700	2000	2400	3600	1500	3600	1500	4500

Marble Work		Mosaic		Ornamental Iron		Electric Wiring		Freight Expense				
Labor	Material	Labor	Material	Labor	Material	Labor	Material	Labor	Material	Total Labor	Total Material	Grand Total
4000	9000	2400	4000	2000	15000	2000	4000	600	2000	64 100 00	161 200 00	227 900 00
								150	200	5 540 00	15 445 00	15 895 00
								160	300	10 990 00	30 600 00	42 050 00

250

FORM H. HEADINGS OF COST LEDGER FOR DISTRIBUTION OF ACCOUNTS.

The upper figure shows about one-half of the first page, the lower figure showing the right-hand half of the opposite page. The two pages together constitute a single "Folio" in the ledger. The columns omitted are:—Iron Work, Fireproofing, Mortar for Fireproofing Rough Grounds, Plastering, Roofing, Sheet Metal, Doors, Windows, Chair Rail, Picture Mould, Base, Glazing, Painting.

used on a third, the second receives a credit and perhaps the first receives a small additional credit. At the end of the job, credit is allowed to it for the value of plant and materials turned in.

Mr. Lahey writes:—"I have found that by using loose sheets and Shannon filing cases, the work is simplified, as the number of sheets required each month varies according to the work on hand."

The sheets must balance with the regular office books, which consist of a time book, journal, and ledger.

In response to a request from the editors of THE ENGINEERING MAGAZINE, a firm of builders who operate on a large scale and over a wide territory have kindly furnished a description of their cost-keeping system, with samples of the forms employed. The latter are reproduced here as Forms H, J, K, and L. This firm writes:—"We do not desire any particular credit for anything of value to you, which you may find in the foregoing, but would rather that you treat the same anonymously." The following description is quoted verbatim from their letter:—

"Our books consist of the regular double-entry cash book, journal, and ledger, together with an independent cost ledger. An estimate of the cost of a particular contract is made on loose leaves of legal-cap size, which are then bound together, labeled, and filed away in a convenient place. If the contract is awarded us, we then open an account with the job, in the cost-ledger, a sample page of which we enclose herewith marked Form H. At the same time an account is also opened with a job on our general ledger, to which all charges and credits of every nature are made from day to day. At the end of each month these charges are transferred to the cost-ledger account, properly distributed and classified, and balanced with the general ledger. This is as often as we have found it necessary to balance our books. However, there is nothing to prevent a comparison at the end of each week, as we receive each day reports of all materials received on a job during that day, for the purpose of checking invoices, on a blank form enclosed herewith marked Form J, and at the end of each week, on pay day, a full financial report from the superintendent in charge, on blank enclosed, marked Form K. This blank, in addition to various miscellaneous disbursements for the week, is entered the total amount of the pay roll. From each workman on the building we take a receipt like sample enclosed herewith and marked Form L. On this receipt the man's time is entered each day by the time keeper on the building, and the time is classified by letter according to a key with which we supply each time keeper. For example:—"A" stands for excavating, "B" for mixing concrete, "C" for laying concrete,

" D " for laying rubble, " E " for laying common brick, " F " for mixing mortar, and so on indefinitely. Each week, upon receipt of these reports from the superintendents, they are carefully audited, the pay receipts classified and recapitulated, and the whole entered on the general ledger, the superintendent's account being credited and the account with the job charged in one amount.

" This all applies to contracts at any distance from our main office. On contracts near at hand, all moneys are handled by our main office, and all charges of every nature are made on the general ledger from day to day, and the cost ledger written up and balanced at the end of the month as heretofore explained.

" A separate account is kept on the cost ledger with all such items

Bonn Building, Art City, Pa.

REPORT OF MATERIAL RECEIVED.

Date Received Sept 3 1902 Car Initial P.R.R. Car No 1462 Freight 42 60

	How Applied
462 Rods 7/8" × 4'-6"	Order No 404
160 " 7/8" × 3'-0"	" "
225 " 7/8" × 2'-6	" "
18 Cast Bases 2'-4" × 2'-4"	" 296
4 " " 4'-0" × 4'-0"	"
From Penn. Steel Co	

FORM J. REPORT OF MATERIAL RECEIVED.

A separate report is made for each kind of material, whether brick, stone, sand, lime, cement, lumber, or stone—just what is on the car and from whom received. If deliveries are made by team, the number of thousand brick or yards of sand received that day are noted.

as freights, traveling expenses, etc., which cannot be accurately classified as they originate during the progress of the work, and when the work is completed they are then properly distributed and the units of cost computed for each branch of the work, to compare with estimated units."

This system appears to contain elements worth some attention, and although it has been " evolved to meet particular requirements," it offers, with a few changes, considerable elasticity. It seems to be adapted to complex operations on a moderately large scale, but might prove unsatisfactory for very extensive works. About the most convenient paper for estimates is in sheets 8½ inches by 11 inches,

SUPERINTENDENT'S STATEMENT OF ACCOUNT.

At Construction office in Oil City, Pa for week ending September 6th 1902

In Account with

RECEIPTS.

DATE		FROM	FOR	
Aug.	30	Balance.		215 08
Sept.	3	Alex. Smith	8 M. old brick	24 00
	5	G. M. M. & Co.	Cash for Pay Roll	450 00
				$473 08

DISBURSEMENTS.

DATE		PAID TO	FOR	
Sept.	1	Ringer & Jones	Blacksmithing	6 75
	1	Sickel, Cooper & Co.	Shovels	12 00
	3	D. C. Mann	Mining & Bell Shears	5 00
	4	Estabrook & Co.	2 Water pail	33
	5	Penn. R. R. Co.	Fgt on Steel	168 00
	6	Self	Car Fare, Board &c.	6 05
	6	Pay Roll		439 95
		Balance.		14 50
				473 08

Receipted Vouchers enclosed

FORM K. SUPERINTENDENT'S STATEMENT OF ACCOUNT.
Original is about the size of legal cap. Signed at the foot by the superintendent.

with a double red line 1½ inches below the top, which is an 8½-inch side, and is punched for Unimatic or I. P. "loose-leaf" books. The books are, therefore, legal fold and made to order. Below the double red line the paper is quadrilled in blue, four to the inch, or thirty-four spaces wide and thirty-eight spaces between the double red line and the bottom of the sheet. Above the double red line are three parallel blue lines spaced ¼ inch apart. On the top line is written the title of the work, with the date on the right-hand side, and, in the three spaces below, sub-title, description, sheet number, etc. Sheets of this size can be conveniently filed with the original correspondence and data, or letters can easily be punched and inserted in the loose-leaf books. When the estimate is finished, the sheets and letters pertaining to it are removed from the book and bound together with a string, through the three holes at the top. They can then be indexed and filed away

NO. 106 RECEIVED OF Henry James CHICAGO, Sept. 9 1902

In full for work on Brown Building, for week ending Sept 6th 1902 as follows: 40 Hrs. at 20 per hr. $ 12 00

DAY	TOTAL HOURS	a	B	n	O																
	8	4			4																
	8	2	4		2																
	4			4																	
	8	4	3	1																	
	8	2	2	3	1																
	4			1	3																
	40	12	9	9	10																
	12 00	3 00	2 25	2 25	2 50																

Certified Charles Baxter Timekeeper Sign here Henry James

The Engineering Magazine

FORM L. WORKMAN'S WAGES RECEIPT. ORIGINAL IS 9 IN. WIDE BY 4 IN. HIGH.

by any system, but vertical files with numbered folders and a decimal system are the most convenient.

It is a good plan to have a standard form for estimates, and to take up each item in regular order. When there is nothing to estimate under an item, it is best to enter the item in its order and write after it "*none.*"

A good substitute for the special "cost ledger" may be made with an ordinary trial-balance book. The ruling is the same as that shown in Form H, and the size and shape of the book is in some respects more convenient. As many pages may be used for a contract as necessary to give two columns for each item, and by cutting off the two outer columns of the intermediate leaves required, the latter will fold back without covering up the date column on the first page.

In many cases it may be advisable to arrange the system so that the cost ledger can be posted from the original records, through distribution sheets, similar to Form B of the Terry and Tench Co., instead of from the general ledger. The amount of work of each kind done in each week or month can be reported and entered on the cost ledger above or below the cost, using two lines instead of one for each entry. The unit costs can then be read from a slide rule almost as rapidly as the results can be written, and may be interlined in red.

The suggestions given above are mostly derived from observation of other systems in use and are only intended to show how variations may be introduced in systems to make them available in other cases.

The writer and the editors of THE ENGINEERING MAGAZINE wish to make special acknowledgment to the contractors who lent their assistance in collecting and furnishing data for this article..

EDITORIAL COMMENT

THE reorganization of the Isthmian Canal Commission appears to promise remarkable success in securing the strength and the freedom of able individual management, while retaining the necessary legal form of a commission. The division of functions is eminently logical, and the character of the men placed at the executive head of the several departments assures energy and ability in the prosecution of the work henceforth. It is especially gratifying that Mr. Wallace, as chief engineer, has been advanced to a rank and dignity in the commission commensurate with the responsibility of his work and his personal and professional worth.

There seems to be some disposition to criticize the reported intention to make the consulting engineering committee international in its membership —criticism based nominally on the supposed difficulty which foreign members might find in apprehending American methods of work. The objection does not seem to be well supported, as the particular function suggested for the advisory board is to aid in the decision upon the type of canal, and not upon the mode of construction. This involves the solution of hydraulic problems, and deductions from experience in the operation of ship canals, in which the best authorities of the world may well be called in consultation. It is doubtless safe to assume that the proposed complexion of the board is thought desirable by the chief engineer, and he may well be depended upon to select the consulting engineers, as he may be entirely trusted afterwards to carry out the plans selected.

Two very interesting documents dealing with canal questions reach us too late for proper discussion in this issue. The first is the report of the chief engineer of the Isthmian Canal Commission for the period from June 1, 1904, to Feb. 1, 1905, giving an admirably clear summary of the work so far accomplished, and indicating unequivocally that the sea-level plan is Mr. Wallace's ultimate ideal. The second is a Project for the Panama Canal, by Mr. Lindon W. Bates, introduced by an impressive preface pointing out the world-wide importance of the undertaking, the duty resting upon the country and the engineering profession to avoid error in carrying it out, and his own conviction that "the announced methods of solution are not such as to secure . . . the best, the safest, and the most enduring canal." "Knowing further that there exists a more scientific method, it has become his duty, as well as his privilege, to set it forth." The project, which is quite new, controls the Chagres by dams at both Gamboa and Alhajuela, and establishes a summit level at about 20 feet above sea, creating two lakes ("Lake Chagres" and "Lake Panama") near the respective ends of the canal and giving a total of 17 miles of lake navigation. We hope to return to this interesting conception with a fuller notice next month.

* * *

A PLEASANT evidence of the growing recognition of "Production Engineering" as a distinct course in technical education comes to us this month in the form of a volume of Dr. Alex. C. Humphreys' "Lecture Notes on Some

of the Business Features of Engineering Practice." They are published by Stevens Institute of Technology as part of the literature of the "Department of Business Engineering," and deal principally with accountancy as applied to the conduct and management of manufacturing and engineering concerns. This, of course, is an important element in the complete scheme of "Production Engineering"; more important still is the approach toward the conception of a specialized course of engineering training, adapted to teach the principles of the efficient and economical administration of industrial work.

* * *

THE announcement of the award of the John Fritz gold medal to Lord Kelvin for his work in cable telegraphy, and for his other scientific achievements, shows that a fitting beginning has been made in the administration of this important charge by the representatives of the four national engineering societies. In all his career Lord Kelvin has shown such a close union between the work of the physicist and the engineer, as a man of both profound theory and of intensely practical application, that the award of the medal to him is a distinct indication of the intention of the founders to make the distinction one of the broadest and most comprehensive scope. With such a distinguished name at the head of the list the attainment of the John Fritz medal will acquire increased value to all succeeding holders, the record forming a roll of fame the admittance to which will constitute one of the highest rewards within the grasp of the profession.

* * *

IN the first report to the steam-engine research committee of the Institution of Mechanical Engineers, reviewed at length elsewhere in this issue, Professor Capper brings out one point which demands more attention than it has hitherto received. The investigations showed that even with an experimental engine, specially prepared for scientific trials demanding the highest degree of accuracy, the leakage past the valves was sufficient to render the conclusions unreliable, had not the amount been measured to enable the correction to be made. Professor Capper even goes so far as to say that with *well-fitted* valves the leakage may amount to more than 20 per cent. of the steam entering the cylinder, and is rarely less than 4 per cent.

If such conditions are found under the surroundings of care and preparation accompanying scientific tests, what may be expected in the ordinary working of engines in mills and factories? Losses by internal condensation are not easy to determine, and can only be partially diminished; but it is evident that we have in many instances wastes nearly if not altogether as great by leakage as from condensation, and this from a cause much more controllable.

The leakage experiments made by Professor Capper were with slide valves only, and it would be of much value to have similar tests made with other forms. Incidentally, it may be a matter of interest to conjecture the extent to which steam-engine trials, hitherto regarded as trustworthy, may have been entirely vitiated by leakage effects, and the re-checking of results and conclusions in some important departments of steam engineering may be in order.

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REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

STEAM-ENGINE RESEARCH.

FIRST REPORT OF THE STEAM-ENGINE RESEARCH COMMITTEE UPON THE RESULTS OF PROGRESSIVE SPEED AND PRESSURE TRIALS.

Prof. D. S. Capper—Institution of Mechanical Engineers.

THE investigations conducted by the Institution of Mechanical Engineers form most valuable contributions to the various departments of work to which they relate, and the first report of the steam-engine research committee maintains the high standard set for it by its predecessors. The present report, prepared by Professor David S. Capper, incorporates the results of experiments made at King's College, London, covering trials with jacketed and unjacketed cylinders and trials at progressive pressures and speeds. These experiments were originally suggested by the late Mr. Bryan Donkin to investigate the subject of initial condensation in steam-engine cylinders. The plan suggested by Mr. Donkin involved the construction of a special steam engine, with three valves,—first, one to admit steam during lead; secondly, one to open at the commencement of the stroke and to act as an admission valve; and thirdly, an exhaust valve. By supplying the first and second valves from separate boilers, Mr. Donkin hoped that the steam required to replace initial condensation might be separately measured. Unfortunately this interesting investigation could not be undertaken, owing to difficulties in connection with the engine, and the researches of which the present paper is a report were made upon an engine of more ordinary design.

The engine, which is described in detail in the report, is a horizontal, cross-compound engine, but in the tests thus far made, only the high-pressure side was used. The cut-off was effected by a Meyer valve gear, adjustable by hand, and the cylinder could be operated by either high-pressure or condensing, and with or without jacket. All the steam passing through the engine was delivered to a surface condenser, the discharge from which was carefully weighed at regular intervals, the engine being indicated and the load controlled on the fly-wheel by a rope brake.

The method of conducting the trials was as follows:

"Observers were placed at the boiler gauge, the engine gauges, the separator and calorimeter, at the indicator, at the brake, at the condenser, and at the condensed-water tank, so that observations of the readings of all the instruments could be taken at frequent intervals. Steam was raised in the boiler to the required pressure, and the engine having been started and run for some time until it was running steadily under the required conditions and steam pressure, the trial was commenced and observations were taken every five minutes for half an hour. If the conditions varied during the run to any considerable extent the trial was continued until a steady run of twenty minutes to half-an hour was obtained. If the trial then seemed generally satisfactory, the conditions were altered and a further trial was run."

From more than one hundred trials there have been selected 38 as most closely satisfying the conditions laid down. The results of these are very fully tabulated in the report, while reproductions of indicator

cards and copies of the heat diagrams are also given.

In order to correct the results of the trials from any errors due to the leakage of steam past the slide valves directly to the exhaust, without passing through the cylinder, a series of tests were made to determine the tightness of the valves. These tests were made by blocking the steam ports, driving the engine at the various speeds by external power, and admitting steam at the various pressures to the steam chest. By connecting the exhaust to a condensing coil all the leakage into the exhaust was measured and the results accurately determined. The results of these tests are very fully detailed in the report, and a leakage ranging from 36 to 56 pounds of steam per hour was found when the engine was standing, and an average of 45 pounds per hour when running at 50 revolutions.

The condensation of the steam, as well as the re-evaporation, together with the rate of interchange of heat between the steam and the cylinder walls, are all fully tabulated in the report, and a résumé of the results is interesting.

Thus, the total condensation up to cut-off increased with increased pressure and temperature of admission. As the cut-off was constant, condensation therefore increases with the difference between the temperature of admission and exhaust. This difference of temperature is sensibly the same for the jacketed and unjacketed series, yet the condensation increases with increase of temperature in a much higher ratio on the jacketed than on the unjacketed trials. The conclusion drawn from the experiments, so far as initial condensation is concerned, is that the losses due to condensation on the cylinder walls of unjacketed engines diminish with increased initial pressure and temperature for a given ratio of expansion quite independently of the rate of speed. It appears that if only the initial temperature could be sufficiently raised, jacketed and unjacketed engines would be equally efficient as regards initial condensation.

The total condensation decreases with increase of speed for the unjacketed series of trials, while with the jacketed series the same decrease appeared on the high temperature tests, and the opposite was shown on the low-temperature trials, the total condensation in the latter cases increasing with the speed.

So far as the rate of interchange of heat between the steam and the cylinder walls is concerned, this rate is about twice as high in the unjacketed trials as in the jacketed trials; this corresponding to the greater depth to which the cyclical temperature variation penetrates when the mean temperature of the cylinder walls is lowered by the absence of the jacket.

The tests showed that the jacket has little if any influence upon evaporation during expansion, and under the conditions under which these trials were carried out the regenerative action of the walls appeared to be quite as high without jackets as with them.

Professor Capper concludes the report with some general conclusions drawn from the whole series of experiments.

"It is dangerous to draw conclusions of too general and sweeping a character from experiments upon one type of engine under one set of conditions, but it may fairly be claimed that the ground covered by this report has never previously been surveyed with an engine showing more consistent and definite results, nor under conditions which enabled so detailed an analysis of the results to be made. It may therefore be anticipated with some confidence that the definite indications shown by the results form a real contribution to the present knowledge of the phenomena accompanying condensation and re-evaporation in an engine cylinder under given conditions of jacketing. The points which have been elucidated may be summarised as follows:—

"Firstly, leakage through the slide-valve, to the importance of which Messrs. Callendar and Nicolson have drawn attention, has been quantitatively determined under defined conditions, and has been shown to be nearly independent of speed of sliding surface and proportional to difference of pressure between the two sides of the valve. Further, it has been shown that the assumption that the leakage is inversely as the overlap of the valve is at least in the main well founded. And further that with well fitted valves the leakage may amount

to over 20 per cent. of the steam entering the cylinder and is rarely less than 4 per cent.

"Secondly, it has been shown that for an unjacketed engine with a given ratio of expansion, initial condensation, expressed as a percentage of the steam in the cylinder, *diminishes* with increase of initial temperature, while the total condensation per stroke *increases* with such temperature increase.

"This, though suggested by Messrs. Callendar and Nicolson's researches, has never previously been demonstrated with clearness, as if leakage is not allowed for, the results are obscured and even reversed, and the conclusions arrived at without leakage allowance are therefore unreliable.

"Thirdly, it appears from the results here obtained that the re-evaporation for a given ratio of expansion is as great and sometimes greater without jackets than with them. This shows very clearly that the regenerative action of the cylinder walls with a given ratio of expansion is largely independent of their mean temperature.

"No quantitative analysis of re-evaporation is possible where leakage is not taken into account, as without the necessary allowance results would be largely illusory.

"Fourthly, it is possible from the results obtained to show the temperature when for any speed of revolution with a given rate of expansion the jackets will become unnecessary or wasteful."

The whole report is an example of careful and accurate research, and a continuance of such investigations should produce a series fully comparable with the masterly reports of the alloys research committee of the same Institution.

BLAST-FURNACE POWER-GAS IN AMERICA.

THE COMMERCIAL POSSIBILITIES OF BLAST-FURNACE GAS FOR THE DEVELOPMENT OF ELECTRIC POWER.

F. du P. Thomson—Electrochemical and Metallurgical Industry.

WE have repeatedly reviewed in these columns papers relating to the development of power by the use of waste gases from blast furnaces as fuel for internal-combustion motors, but in all cases these have referred to installations on the Continent, in Belgium, in Luxembourg, and in Germany. We now have a valuable paper by Mr. F. du P. Thomson, in a recent issue of *Electrochemical and Metallurgical Industry*, discussing the large gas-power plant of the Lackawanna Iron & Steel Company, at Buffalo, this paper being based upon the author's own practical experience with the only large installation of the kind in the United States.

Two things are essential to the success of a blast-furnace gas-power plant. There must be an available market for the surplus power over and above that required for the blowing engines of the works, and there must be an uninterrupted and fairly uniform supply of gas.

"To secure, within a reasonable degree of certainty, a continuity of supply, no group of less than three blast furnaces can be considered as available to supply a power plant, which is intended to produce power for the general market. At any group of furnaces at least one will at some time be out of blast for relining, and at least one other furnace may be stopped for some one other reason. With a group of three blast furnaces, therefore, the surplus gas of one will always be available.

"The value of a large number of units to obtain a given output of iron is very evident, if the development of a large percentage of the surplus gas into power is to be made possible. Increased cost of construction and operation of a blast furnace plant made up of a number of small units as compared with the same items of expense for a plant of the same capacity made up of large units, must be more than balanced by the profits which are to be realized from the operation of the larger power plant. Further than this, the prices obtained for the power must warrant the continuance in blast of all but one furnace of a blast furnace plant, when trade conditions would imperatively dictate a suspension of operation. The profit must at least pay the interest on the labor and material invested in manufacturing periods in which there is no market for the product and at

least part of the loss due to a falling market.

"The blast furnace gas power plant is burdened with the responsibility of maintaining operations in spite of trouble which may occur at ore, stone and coal mines, coke ovens, along the lines of transportation, and finally at the blast furnace plant itself."

The general distribution of power derived from the furnace gases is shown by Mr. Thomson by a general analysis of the total amount of contained energy into the various proportions required for use in the production of iron, and the surplus available for the production of electricity for outside supply.

"The waste gases of the blast furnace contain about one-half of the total heat originally possessed by the fuel, and this is approximately in direct proportion to the coke consumption per ton of iron. It has been variously estimated that from 18 to 33 per cent. of this heat is required to heat the blast. A conservative estimate of the percentage of the heat of the waste gases to heat the blast would be 30 per cent., and one which would not, in general practice, be exceeded. For the compression of the blast by steam engines, giving an economy of 20 lb. of steam per horse-power per hour when run condensing, under normal conditions, with boilers which convert 60 per cent. to 70 per cent. of the heat of the gas burnt into heat of steam, requires from 33 per cent. to 40 per cent. of the heat of the waste gases. For auxiliary purposes, such as pumps, light power for hoists and ore-handling machinery, approximately 7 per cent. to 10 per cent. is required. By the substitution of gas blowing engines and gas engines for the production of power for auxiliaries, the figures above may be reduced to read 16.5 per cent. to 20 per cent. and 3.5 per cent. to 5 per cent.

"The wide difference between the surplus available under the head of steam engines, 42 to 17 per cent., is due principally to differences in efficiency of apparatus and only in a limited degree to differences in practice. The difference in surplus available under the head of gas engines, 52 to 42 per cent., depends almost entirely on differences in furnace practice, for the efficiency of the gas engine equipment is in each case the same. The maximum surplus with steam equipment is, curious to say, identical with the minimum to be expected with gas engine equipment.

"The superiority of the gas engine over the steam engine may appear rather small. It must be remembered, however, that the gas blowing engine operates normally at only about two-thirds of the load which it must be designed to carry when the blast pressure reaches 25 lb. to the square inch. Such periods of high pressure may be coincident with a poor quality of gas, making the conditions even worse than indicated above. The gas engine in such service is at a disadvantage compared with a steam engine designed to operate with economy at normal load, with capacity, however, to supply air at the highest pressures met with in general practice.

"Large gas engines are built to-day, which will, at full load, give a duty of 194,000,000 effective foot pounds, as compared with a duty of 82,000,000 effective foot pounds, from one of the best steam engines per 1,000,000 B.T.U. in the gas consumed in each case. As the economy of the gas blowing engine will approximate only 80 per cent. of the figure given above, it may readily be seen that its ultimate economy, in blowing engine practice, may be safely said not to exceed twice that of the steam engine."

Mr. Thomson discusses at length the methods and appliances employed for cooling the gas and freeing it from dust. The most effective gas washer has been found to be a fan, at the centre of which a jet of water is delivered, the fan breaking up the water into spray and mixing it with the dust, and at the same time delivering the mixture of water and dust out of the current of the gas by centrifugal force.

The commercial side of the question is dealt with by Mr. Thomson by considering two different classes. In the first class (A) provision is made for possible momentary overloads of 50 per cent., this requiring a gas engine of 2,000 horse power coupled to a 1,000 kw. generator. In the second class (B) the full load of the generator is taken as 80 per cent. of the engine capacity, and the generator load never exceeds 25 per cent., this being represented by a 2,000 horse power gas engine coupled to a generator of 1,500 kw.

In either class the space occupied would practically be the same, and require for each unit a length of 50 feet in a building 75 feet wide, together with some additional length to house the compressors, pumps, and exciters which go to complete the installation. No proposition except one which utilizes all the surplus gas need be considered. The following estimates are based upon the utilization of the surplus gas from a group of three or four 300-ton furnaces, in which the surplus gas from one furnace only may be utilized.

Taking the first class as consisting of four 1,000 kw. units, and the second as four 1,500 kw. units, the total costs are tabulated in detail, the totals being $580,000 and $600,000 respectively; corresponding to $145 per kilowatt for the first class and $100 per kilowatt for the second. The operative costs are tabulated in a similar manner, and work out at $90.24 per kilowatt year in the first case and $38.40 for the second; while assuming a profit of 10 per cent. the selling prices should be $128.70 and $55.15 per kilowatt-year respectively.

In general an increase in profits of about 30 cents per ton may be realized by the utilization of the waste gases, and since this is true from a plant which can convert but 25 per cent. of the surplus gas available, still better results may be expected from those at which the percentage of surplus convertible, owing to a greater number of furnaces, is greater. It should not be impossible to realize 75 cents, or more, per ton, where eight to ten furnaces are grouped.

"Wherever there is a large demand for power, and cheap water-power is not available and blast furnaces are, the blast-furnace gas engine power plant need fear no rival. We are not far from the day when the power house will be as much a part of every modern blast furnace plant as are the condenser and ammonia houses of the modern by-product coke plant."

THE SURFACE FINISHING OF METALS.

A REVIEW OF SCIENTIFIC METHODS OF STUDYING THE PHYSICAL STRUCTURE OF METALS BY AN EXAMINATION OF POLISHED SURFACES.

F. Osmond and G. Cartaud—Revue Générale des Sciences.

DURING the past few years the study of the physical structure of metals used in engineering work has become very general. It is well understood that the methods of metallography should not be permitted to displace those of chemical analysis, while the records of the testing machine must always be employed by the conscientious engineer, but in many cases the microscopical examination of polished and etched surfaces will explain peculiarities of behaviour, and reveal the consequences of manufacturing processes in a manner otherwise impossible.

Apart from the care which is necessary in the examination of the physical constitution of a metal under the microscope, an important element in the attainment of reliable results is found in the preparation of the surface of the material under consideration. For this reason the paper of MM. Osmond and Cartaud, in a recent number of the *Revue Générale des Sciences*, is of especial value, especially as it includes the experience gained by the former engineer of the Creusot Works, as well as that of an eminent French chemical engineer.

Leaving aside the details of etching and examining the metallic surfaces, the authors devote themselves especially to the preparation of the surfaces themselves, considering the methods of polishing as otherwise preparing the selected space for examination, and showing how this preparation may affect the results obtained.

Although the polishing of metals is one of the oldest of the arts it is one which has been almost entirely neglected in technical literature. Those investigators in the science of metallography who have made the most valuable contributions to our knowledge of the physical structure of metals have in nearly every instance been compelled to develop with their own labor the methods necessary to produce surfaces suitable for examination, while it may be shown that when the surface is not properly prepared the conclusions drawn may be altogether misleading.

When the surface of a metal is reduced,

either by a file or by such a medium as an emery paper, every tooth of the file and every grain of emery produces a scratch, the surface thus produced consisting of a mass of such scratches. Apart from the removal of the material effected by such means, the production of a scratch or similar break in the surface of a metal produces a very appreciable influence upon the material immediately surrounding, and as such methods form a portion of the operation of polishing preliminary to metallographical examination, these effects demand attention. Thus, when a depression is made in the surface of a metal by the point of a punch, or by a steel ball, as in the Brinell test for hardness, there will be produced what may be termed a series of undulatory waves in the mass of the material, and if the depression be produced far enough the deformation may develop lines of rupture within the material. In like manner the production of grooves or scratches by any tool, such as a file, will cause the development of internal stresses, so that the skin of the metal, as it may be termed, is in a different molecular condition from the interior of the mass. The extent of the effect of a scratch depends to a large extent upon the brittleness of the material. Thus the scratch of a diamond upon a piece of glass will affect the material so that it may be easily broken along the line of the break in the skin, while a scratch upon a material like gelatine or rubber may cause a more distinct break in the surface with a much shallower effect within the material. By examining scratched surfaces under the microscope the effect of the breaks in the surface upon the surrounding material may be studied, and the influence of the methods of preparing the surface is clearly visible.

The usual method of polishing a surface for metallographical examination includes the removal of a portion of the metal by some smoothing tool, such as a file, followed by a polishing by emery papers or cloth, of successive finenesses, the final specular polishing being effected by the use of some almost impalpable powder, such as rouge, tripoli, or as is now more generally employed, either alumina or chromic oxide, levigated according to the Schloesing process. By the use of such polishing materials a surface of a high degree of brilliancy may be obtained, and this, after having been subjected to the corrosive action of some etching medium, can be studied under the microscope.

However complete the polishing may appear, the operation really differs in degree only from the earlier stages in the preparation of the surface. The gradual increase in the fineness of the abrading material acts simply to produce finer and finer scratches, until the visible marks have been replaced by invisible ones. It has been assumed that this operation removes the surface film, which, according to Beilby, differs in physical constitution from the metal beneath, and that a new strained surface film is not produced, but this does not necessarily follow. In many instances the highest and most brilliant polish acts simply as a mask to conceal the artificial skin from the eye, while the application of either chemical or mechanical revealers will demonstrate the fact that the altered surface layer is still there. These facts are clearly shown by reproductions of a number of micro-photographs of etched surfaces, in which the action of etching solutions has brought out the lines and markings made by the operations of polishing the metal, and which to the untrained observer might give wholly erroneous ideas concerning the structure of the metal.

Another interesting method of revealing the existence of skin defects in a metal is the production of a new set of mechanical deformations. Thus, if deformation lines, sometimes called Lüders lines, such as are caused by punching or otherwise straining the material, be entirely polished out, so far as the eye can see, and the metal be subjected to a new method of deformation, such as pulling in a testing machine, the lines of the first deformation will re-appear upon the polished surface, showing that the molecular deformations had been masked only, and not removed. A similar action may be produced under the microscope, and a surface, apparently fully polished, will reveal surface lines if the skin be broken, as by the scratch of a diamond, if the specimen be subjected to pressure.

All these experiences go to show that the methods of preparation of a specimen for examination under the microscope act to create conditions of surface strain, amounting in some instances to an actual flow of

the metal to an appreciable depth, and causing the polished surface to be very far from representing the true physical condition of the interior of the mass. It is altogether possible to avoid these deceptive conditions, at least to such an extent as to reduce the surface film to such a slight depth as to permit it to be readily penetrated by the etching solution, and this means that the greatest care should be taken, not only in the final polishing, but in the preliminary reduction of the surface, and in all the details of preparation. The service which the science of metallography has rendered in extending our knowledge of the physical constitution of metals is very great, but it should always be remembered that it must be used with judgment and with such a degree of care and skill in all details as to permit the conclusions to be accepted with the same freedom from self-deception as exists in other methods of investigation.

INTERNAL WATERWAYS IN GREAT BRITAIN.

AN EXAMINATION OF THE TRANSPORT POSSIBILITIES OF BRITISH INLAND NAVIGABLE WATERWAYS.

B. H. Thwaite—Society of Engineers.

NOTWITHSTANDING the development of improved systems of transport, both by steam and electric traction, there exists a tendency to advocate a return to water transport as a method which, while slow, must always remain one of the most economical systems for conveying bulky merchandise. In France the canal system has never been allowed to fall into decay and disuse, and in Germany there has been for a number of years past a determined effort to create a great system of internal waterways, composed of canals and canalised rivers. In England, on the contrary, the former extensive canal system has been permitted to deteriorate and fall largely into disuse, until at the present time it is at a condition of very low efficiency. In a valuable paper presented by Mr. B. H. Thwaite before a recent meeting of the Society of Engineers the possibilities of the internal waterways of Great Britain are discussed, and it is shown how the canal system may be restored to a high state of efficiency and made an important factor in rebuilding the agricultural prosperity of the country.

Mr. Thwaite reviews at some length the original development of the canals of England, and shows how closely they were connected with the prosperity of the nation down to the period when railways came into use. During the railway inflation period, after 1830, culminating in the boom of the forties, canal promotion enterprise was entirely overshadowed.

"The neglect of the canal system, as the result of the railway boom and government indifference to the fate of the canals, followed by the depreciation of the canal stocks, permitted the railway companies to initiate a policy of absorption as a preliminary to the destruction or suppression of their traffic competitor as far as practicable. For instance, the great railways purchased such lengths of canals as constituted competition against themselves, and which at the same time formed important links in the British navigable waterway system. This action destroyed the canal ensemble, and gave the railways the power of determining through canal rates. Thus whilst in the forties the agricultural interests were being attacked by the effect of the fiscal policy of free imports, the canal transit facilities of that industry were being undermined by the action of the railway administrators, in purchasing wherever desirable canal and other inland navigation rights at a price that was a bagatelle, compared with their intrinsic value. The government of the time could not have realised the effect of their indifference to the canal interests on the national well-being otherwise it would surely have been impossible for any railway board to have overridden the provisions of the Canal Acts."

"To-day we have a practical example of the policy of *laissez faire*, in the British railway system, which charges rates for railway transport in excess of the rates of our most dangerous industrial and commercial rivals. Our statesmen of the for-

ties appear to have forgotten the axiom that the provision of the most efficient and economic transport arrangements is an all important step towards securing industrial and commercial prosperity. Subsequent governments realised their mistaken policy, but the passing of the Act of 1888 relating to canals was only an illustration of the policy of locking the stable door after the horse had been stolen. That Act forbids railway companies, in the absence of special and statutory authority to take over the control of canals. It also authorises canal companies to make arrangements with each other for through tolls, rates and traffic. Despite this Act the railway companies still hold their grip on the canals, although since the passing of the Act railway companies have shown a tendency to relinquish their canal properties, the Great Western Railway and the Midland Railway Companies having given up their control over important canals. However, British statesmen are becoming rapidly converted, and the passing of the Manchester Ship Canal Act in 1885 was a red letter day in the history of our canals."

Mr. Thwaite examines the advantages of transport by canal for certain kinds of merchandise in a very clear manner, showing how very cheap it is, and how it can be made still cheaper.

"A casual analysis of the broad distinctions that separate a canal system from a railway system demonstrates the *primâ facie* advantages of the canal system for the carriage of cattle, agricultural products, and the raw materials required for our factories, or generally for the carriage of heavy freights at slow speeds, or in which time is not the essential qualification of the transport system. For example, the capital cost of a canal is a mere fraction of that of a railway. The cost of a 50-ton capacity canal boat is far less than the cost of railway trucks of equivalent capacity. Moreover, the durability of canal boats is measured in terms of years and is very much greater than that of railway trucks, and it must obviously be so when the comparison of the nature of the traffic is considered, the almost destructive violence and smashing and clashing features of railways is absent from canal operations.

"Certainly, a reliable water supply source is necessary to satisfy lock and evaporation losses, but there is none of the expensive rail-wear associated with rail permanent way. The cost of making English canals is fairly represented by the figures of £3500 per mile. Against this the cost of railways per mile of formation looks seriously formidable if represented by the figure of £46,000 per mile. The capital amount actually paid up per mile of English and Welsh canals is said to equal £8472. The capital invested in British railways is said to be equal to £52,370 per mile."

The actual relation between the cost of freight transport by rail in various countries, as compared with canals, is tabulated as follows, showing the ton-miles to be had for the cost of a penny under the various systems:

British, rail	Ton-miles for a penny	1.25
French, "	" " "	1.66
German, "	" " "	2.00
America, "	" " "	4.00
Canal, horse haulage	" " "	13.00
Canal, electric haulage	" " "	24.66

This brings out the real contention advocated by Mr. Thwaite, the development of canals by the application of electric traction. Various methods have been proposed for this purpose, and any system, to be successful, must be applicable to existing canals without requiring extensive alterations. The so-called electric horse, a simple form of motor hauling device, offers the greatest advantages, and experiments in Germany and elsewhere have shown the entire practicability of the method. The plan proposed by Mr. Thwaite provides for the carrying of the traction motor on a single rail, supported on posts erected on the former tow path, a second higher rail on the same posts carrying a similar motor for traction in the opposite direction, this enabling boats to pass each other without entanglement of tow lines.

The important question in connection with electric traction on canals is the cost of the electrical energy, and this Mr. Thwaite proposes to meet by the utilisation of the energy in the waste gases of blast furnaces. By the employment of furnace gases in large gas engines the necessary electric power could be obtained from fuel

now going to waste, while the application of this power to canal traction would create a revival in internal transport and consequently in industries dependent thereon.

"The following is an estimate of the cost of nationalising, perfecting, and electrifying our canal system. Assuming that 3500 miles of the canal system of Great Britain were purchasable at two-thirds of their original cost of construction, say £2350 per mile of length, then the capital required would be £8,225,000. Allowing £500 per mile for the cost of standardising the locks, and £2000 per mile for the electrification of the canals, then the total amount required would be £16,975,000. Allowing the balance to make up 20 millions to be set aside for working capital, it should secure for the State a splendid transport property. Seeing that over 60 millions sterling have been expended in tramway systems in this country, and that over 300 millions sterling have been absorbed in municipal work, the Government could surely be permitted by the country to become, like France and Germany, the owners of an efficient, electrified, navigable, inland water service.

"The proposed electrification of our canal system would, moreover, provide a cheap supply of electric power for export service, as well as for pumping, irrigation, ploughing, churning, milling, and vegetable and flower growth. The revivification of our inland navigable waterway system would go far towards securing a revival of our agricultural prosperity."

THE ELECTRIC DRIVING OF MACHINE TOOLS.

A REVIEW OF THE ADVANTAGES OF APPLYING INDEPENDENT ELECTRIC MOTORS FOR DRIVING MACHINE TOOLS.

George T. Hanchett—Electrical World and Engineer.

IT is evident that there is now little or no uncertainty as to the advantages of electricity for the transmission of power to tools in the machine shop. The troubles and inconveniences of shafting and belting, and the uncertainty of the losses involved by their use have long caused managers and engineers to hope for something better, and no one would now think of planning a new shop with any other medium than electricity for driving the machinery. At the same time there are several questions to be discussed in connection with electric driving, and it is beginning to be realized that the mere question of the amount of power to be saved is but a minor element among several which go to make up the arrangement of an electric power distribution system in a shop. In a paper in a recent issue of the *Electrical World and Engineer* these questions are discussed in a very clear manner by Mr. George T. Hanchett, from whose article we make some abstracts.

"The advantages of driving tools directly by motors are the following:

"1. Saving in time. 2. Increased output of the tool. 3. Convenience in shop arrangement. 4. Saving in power.

"These items are placed in their order of importance. The first three items pertain to saving in time, the last to saving in power. Modern machine shop practice has shown that machinist's time at $3 per day is a more important item than electricity at 10 cents per kw-hour, and the comparison of these items is so marked that in the writer's opinion it is good practice to carry motor-driven machine tool driving to a far greater extent than has commonly been considered good practice. The motor-driven machine tool permits of being placed in any position without regard to countershafting, and therefore in the best position with reference to light. An item of even greater importance is that each man's tool may be placed in close proximity to his bench, so that it is but a step from one to another. Much time is lost in walking about a shop and in carrying heavy work from a machine to the bench, or vice versa.

"The absence of counter-shafting also enables an elaborate trolley system of I beams to be suspended over the tools so that heavy work can be moved from place to place and swung into the lathe or planer with great facility. It is, furthermore, possible to group tools in such a way that progressive processes will be possible; that is to say, the piece of work can pass from

shaper to lathe and to drill press in such an order that the least time is consumed.

"The convenience of manipulation now being apparent, it is well to spend a few moments' consideration upon the expedition with which the work can be performed once it is in the tool. It is a notable fact that machine tools almost without exception are under-belted; that is to say, the belt width is not capable of driving the tool with all the force that the machine itself will stand. Some tools, indeed, are more favorably belted than others, but the exigencies of installing a belted outfit often requires that the belt be unfavorably short or with the tight side in the wrong position or at an improper angle—very often directly vertical, in which position a belt has minimum power. With the direct application of a motor to a tool, which should always be by some positive drive, such as a chain or gear in order to eliminate the belt difficulties just mentioned, the motor may be proportioned so as to develop all the force that the tool will endure, and therefore much saving in time is gained by taking the heaviest possible cuts. Furthermore, the proper application of motors to tools has unquestionably developed the fact that work of large diameter can be handled in machines that were totally inadequate for the purpose before, the range of the machine being thus enhanced.

"Speed of cutting is another item to which little attention has been paid in the past in the average machine shop. The machinist steps his belt until it has a speed which appears to him "about right," and then finishes the entire job at that speed. If a lathe, the speed may be right on the large diameter and altogether too slow for the small diameter, but the time consumed in stopping the lathe and changing the belt is an item which usually constitutes an inconvenience so great that it is neglected. With the motor-driven tool the machinist can start the small diameter cut at high speed and as the tool feeds outward the controller can be stepped down, and this, combined with the possibilities of heavier cuts, very frequently reduces the time 50 per cent.

Mr. Hanchett very properly places the saving of power by the installation of electric driving as the last element to be considered. As a matter of fact the consumption of power forms a comparatively unimportant element in shop cost, and the extent to which electricity aids in the saving of labor and time far outweighs any power economy which may be effected. As a matter of fact there is a fair saving of power, although this is not so great as was at first supposed might be the case. In a well arranged shop it has been shown that the power consumed by the shafting and belting under the old arrangement was about 40 per cent. of the total; while with electric driving the proportion of power required for the transmission and subdivision may fairly be taken at about 30 per cent. of the whole. With electric driving there is the further advantage that a greater proportion is saved when tools are not in use, and as about one-half the tools are out of active operation during the day the efficiency of the motor driven shop may be taken at about 80 per cent. as against 60 per cent. for the shafting and belt driving system.

"In finally deciding the matter, a great deal of practical sense is necessary. The various advantages of machine tool drive—and it may here be properly reiterated that saving in power is one of the least of these—should be carefully considered and equated against the added investment, which it is safe to assume is 200 per cent. greater than with belts and counter-shafts, from an investment standpoint. From a maintenance standpoint, however, it will usually be found that a properly designed motor-driven installation will show a saving over the belt-driven proposition; for the attention that belts and counter-shafts require, the wearing out of belts, their breakage and the loss of time thereby entailed is greater than will obtain with the motor-driven proposition.

"It is practically an impossibility to say in a general way where individual drive should cease and where group driving should begin. Every shop presents a different problem. It is usually safe to drive groups of like tools which are being constantly used, such as in brass departments where many small parts are being drilled and tapped continuously by cheap help, partly for the reason that there is no necessity for great power at the tools, partly because individual drives would result in undue expense due to the large number of small motors, partly because the saving in

power is microscopic, due to the fact that the department is running continually, and partly because shop arrangement is not of paramount importance, and the help in such a department usually stay constantly by the tool and pass the work from the box on one side of the tool to a box on the other and do practically no bench work. On the other hand, very large tools and groups of tools which are operated by expensive machinists who alternate from tool to tool and from tool to bench, can almost always be profitably driven by direct drive. In any of these cases, however, special advantages due to the situation may arise which will materially alter matters; therefore, each case must be treated by itself."

Mr. Hanchett takes up the subject of methods of variable speed control, showing that this may be practically accomplished in any one of three methods, viz., by varying the armature voltage; by varying the strength of the field; and by varying the number of effective conductors on the armature. Of these the method of feed control appears to be best adapted for motors driving machine tools, while excellent results have also been obtained by the employment of a balancer in connection with control by armature voltage. Combinations of the several control systems have also been used to advantage, and this is a matter which should be decided for every case according to the requirements, after a study of the character of the tools and the nature of the work.

SPEED LIMITS OF GAS ENGINES.

CONSTRUCTIVE AND OPERATIVE LIMITS TO INCREASE IN ROTATIVE SPEED FOR INTERNAL-COMBUSTION MOTORS.

Herbert L. Towle—American Machinist.

IT has well been said that it is exceedingly unsafe to predict the limitations to the development of any branch of art or science, and the impossible of one generation sometimes becomes the daily experience of its successor. When, however, the conditions of the problem are clearly stated and understood it is both possible and desirable to determine the limitations which surround their observance. In a paper in a recent issue of the *American Machinist*, Mr. Herbert L. Towle discusses the ultimate limit of speed in gas engines, and viewed in the light of the conditions set forth, his deductions are interesting and valuable.

In the first place, Mr. Towle discusses only the small, high-speed internal-combustion motors such as are extensively used for driving automobiles and motor boats. Such machines have at present no standard speed, either rotative or in piston feet per minute, the practice of different makers varying materially. The original idea of Daimler, when he undertook to re-design the heavy stationary gas engine into a small, light, and yet powerful motor for vehicles, was to improve the mechanism so that the speed might be greatly increased, and thus permit the power to be increased and the weight diminished. In his day the ignition appeared to be the limiting element, and hence he replaced the old Otto slide by the hot-tube ignition, and this has since been superseded by the electric spark, and at the present time the normal piston speed of these little engines, if such a thing as a normal speed may be admitted, is about 900 feet per minute, which, when accelerated for racing, reaches 1,200, 1,400, or even 1,500 feet per minute for hours at a time.

In considering the whole subject, Mr.. Towle puts the following questions:

"First, what is the highest speed, in an engineering sense, possible; and, when this highest speed has been determined, with what degree of closeness can the normal running speeds of commercial motors be brought up to it?"

The practical obstacles suggested by builders to high motor speed may be summarized as follows: 1, Vibration; 2, Wear of piston, rings, and bearings; 3, Sluggish flame propagation and decreased torque; 4, Overheating; and to these general wear and tear may be added. At the same time none of these is sufficient, from an engineering point of view, to fix definitely the ultimate limit of speed.

"Vibration has already been amply dem-

onstrated to be negligible in vertical motors of four or more cylinders, and, for moderate powers, not of serious moment even with three cylinders, except perhaps at certain critical speeds, when the vibration period of the motor happens to synchronize with that of the springs on which it is mounted, or the hull in which it is placed.

"Ordinary wear is simply a question of bearing surfaces, proper materials, and efficient lubrication. The last is indeed a difficult problem, and many builders, especially of the older type of launch motors, do not know how to lubricate effectively such parts as the crank and wrist pins. Still, the most efficient lubrication possible is by no means so common as it some day will be, at least where small engines are concerned. As to the piston and its rings, there is no way to save them from wear, but we may be very sure that if there were no other objections to high speed the purchaser would cheerfully pay the cost of new rings and an occasional new set of pistons, and of the necessary reboring of the cylinders, for the sake of getting, say, 15 or 20 horse-power, instead of 10, from a given size of engine.

"Rapid flame propagation may be secured by an intense spark, and, if necessary, by igniting at two or more points within the cylinder. Even in the fastest automobile motors multiple ignition is hardly considered necessary to-day, and there is no immediate prospect of our being compelled to exhaust the possibilities in this direction. It is indeed necessary to use high compression, and a very good carburetter, if high piston speeds are aimed at, but each year sees carburetters improved, and high compression is no longer the bugbear of designers that it used to be. Compressions of 90 or 100 pounds per square inch are now used successfully in many automobile engines.

"Overheating of the piston and of parts projecting into the combustion space is undoubtedly a frequent factor in restricting speed. Its influence, however, is rather indirect, since its effect is to necessitate a moderate compression, with which high speed is hardly possible. It might be imagined that this factor would be a serious one, but it has not been found so, at least with cylinders up to 8 inches in bore, and it seems probable that piston diameters of 9 or 10 inches can successfully be used with high compression in gasoline engines, before recourse must be had to water injection or other devices to prevent premature ignition."

The question of getting the fresh charge into the cylinder and the exhaust out of it, is a problem requiring mechanical ingenuity, but by the employment of multiple valves of sufficient size, this matter can be provided for.

The real limit to rotative speed, in the present state of the art, is the same as exists in other reciprocating engines, that is, the inertia effects of the reciprocating parts. Thus, the inertia force of the piston, wrist-pin, and connecting rod, acts as a drag on the crank pin at the beginning of the stroke, while at the end of the stroke it tends to hasten it. If, at the upper or outer end of the stroke this force exceeds the compression pressure in the cylinder, there will be trouble. This will be clear when it is considered that unless the compression exceeds the opposing force to a sufficient degree to hold the parts in contact, the connecting rod will be lifted until the slack of the crank-pin bearing is taken up, and when the explosion comes it will drive the rod down on the pin again, producing a destructive knock.

Mr. Towle gives the well-known formulas for computing the inertia effects for various weights and speeds, and also constructs diagrams enabling the question to be solved graphically. Applying the computation to an engine of 6-inch bore by 7-inch stroke, with reciprocating parts weighing 13 pounds, it is shown that the running speed of 1,000 revolutions per minute is just about the practical maximum for this machine, and that any higher speed would cause destructive knock. A similar calculation for a 4 by 5-inch engine in which the reciprocating parts weigh 6 pounds, shows that with a speed of 1,200 revolutions the inertia force and compression are nearly equal at 50 degrees.

"As this speed is frequently exceeded in automobile motors, the reason for the abnormally light design of the pistons and rods of engines of the De Dion type is at once manifest. The factor of safety in these parts is hardly large enough to be

worth considering, but it is only the paucity of this factor that makes such speeds practicable on any terms. These motors have at least shown that by using a piston length only equal to the diameter with semi-steel for material, and the very thinnest and most accurate of castings, as piston for a bore of 100 millimeters can be made to weigh only a trifle over 2 pounds, and the connecting rod and wrist pin will weigh less than as much again. We may therefore say that for ordinary launch engines the limit of speed is from 1,200 revolutions per minute for small engines down to about 800 revolutions per minute for the largest."

Having determined the practical maximum rotative speeds for existing designs of small internal-combustion engines, Mr. Towle maintains that there is no good reason why these speeds should not be at once made the normal speeds for continuous running. By applying the system of forced lubrication, already accepted in high-speed steam engines, turbines, and other machinery, no trouble need be experienced with bearings, and the knowledge that the maximum limit is not really exceeded enables the machines to be operated with a full sense of safety.

Of course the entire discussion of Mr. Towle relates to reciprocating engines, but if the reciprocating parts are altogether dispensed with, the limitations consequent upon their use disappear with them. If the gas turbine can be made an accomplished fact, as it may be before very long in the form of the mixed gas and steam turbine, there is no reason why it should not find immediate application to automobile vehicles as well as to motor boats. The problem then will be not to attain a sufficiently high speed for the engine but rather to find an acceptable means of reducing it. Probably frictional driving gear, with all the advantages of graduated speed control, will enter into practical service, since the high linear speeds involved would mean correspondingly low surface contact pressures, and thus the speed limit would probably be transferred from the control of inertia forces to the meeting of direct centrifugal stresses, and the problem simply takes another form.

THE COST OF ELECTRIC POWER.

A DISCUSSION OF THE INFLUENCE OF THE LOAD FACTOR ON THE COST OF PRODUCING ELECTRIC POWER.

E. M. Archibald—Canadian Society of Civil Engineers.

THE manufacture of electrical energy for sale to outside customers has brought out a number of problems which demanded little or no attention in the earlier practice of power generation for general manufacturing and mill purposes. The well regulated factory runs along for a certain number of hours every day, and the load, while it may show a gradual tendency to increase until the engine and boiler find themselves staggering along under all they can bear, does not show any very great fluctuations in the course of the working day. There are exceptions to this rule, and some may remember the small machine shop in which all the other machinery was thrown off towards afternoon twice a week in order that the foundry blower might be run up to speed. With the introduction of electric lighting and the gradual development of the central power station, however, it has been realized that there are certain well defined oscillations in the demand for electrical energy for correspondingly distinct purposes, and the question of the equalization of the load factor has become an important matter to the central station engineer. In a paper recently presented before the Canadian Society of Civil Engineers by Mr. E. M. Archibald, the influence of the load factor upon the cost of power is discussed, and some extracts will be found of general interest.

"The great desideratum for an electrical system is a high load-factor with consequent greatest return on investment; load-factor being the ratio of average to maximum load. All the factors of expense included in cost of power to the consumer are then operating at maximum economy, and cost of power is at a minimum.

The lighting of residences and offices produces a peak in the late afternoon and evening, with but little load the remainder of

the twenty-four hours; consequently the average load on the plant with lighting only is very small and the load-factor low. A commercial motor load in connection with lighting will increase the average load even though causing a greater peak. The addition of a street railway load still further increases the day load, but in consequence of the heavy demand load during the rush hours, when the public is going to and from business, which occurs at the peak load on the plant is greatly increased. This heavy peak, with but a small average load over the twenty-four hours, produces a low load-factor, and a portion of the machinery being shut down the greater part of the time, higher rates must be paid by the consumer to secure a certain return on first investment than when the load-factor is higher.

"Evidently, when the load-factor is 100 per cent., that is, when the load is constant throughout the twenty-four hours, and all the machinery is in continuous operation, the cost of power per kilowatt-hour is a minimum, and the greatest return on investment is realized. Customers having a steady load or with high average load are greatly desired and may be offered better rates than all others. It will be the endeavor of this paper to determine the decreased cost of power with increasing load-factor.

"The storage battery is evidently a means in the hands of the power producing company of increasing the average load on the machinery. By charging the battery during light load and discharging during periods of heavy load, a more constant load on the generating apparatus is produced, with consequent better efficiency, and at the same time acting as a reserve in case of accident in the power plant. Unfortunately the battery is expensive, and a loss occurs in its operation which greatly reduces the higher efficiency secured by the increased load-factor. The great benefits obtained by its use are reserve capacity and voltage regulation, enabling the use of more efficient lamps."

Apart from the methods which may be employed to equalize the load, Mr. Archibald undertakes to examine, for a plant of an assumed maximum peak load, the effect which various load factors have upon the cost of the power produced. In doing this he divides the expenses involved in the cost of power into three elements; management; distribution; and production. The first of these, the cost of management, is practically constant for a given peak load, regardless of the load factor. The second element, the cost of distribution, does not vary, so far as the fixed charges and maintenance cost are concerned, but the losses in distribution do vary with the load factor, and as a rule will become a smaller percentage of the total the higher the load factor.

The principal element for consideration, therefore, is the effect of the load factor upon the actual cost of the production of energy.

In examining the cost of production the first cost of the plant involves an equipment sufficiently large to deal with the maximum peak load, and this is taken by determining the plant for a 100 per cent. load factor, and basing the interest, depreciation and other fixed charges upon this amount. The operating charges themselves are variable with the load factor, and may be divided into: labor, oil, and waste; supplies, water, and repairs; and fuel.

The cost of labor varies to a certain extent with the load factor, but the minimum number of men is reached at about 40 per cent. load factor, below which this item remains constant. The cost of oil and other supplies, as well as of water, and of repairs varies almost directly with the load factor, while the cost of fuel varies with some power of the load factor less than unity, depending upon the number and efficiency of the units employed.

Mr. Archibald gives in his paper a number of diagrams in which the various relations are plotted in the form of curves, for which the reader must be referred to the original, and from these some valuable deductions are drawn.

"The higher the load-factor the greater becomes the ratio of variable to fixed charges, and extra investment is advisable to secure the greatest economy possible. Extra investment in coal-handling apparatus and economizers will reduce the cost of labor and fuel in greater proportion than fixed charges are increased; the economizers also provide greater boiler capacity

and purer feed water, reducing cost of repairs.

On the contrary when the load-factor on a system is low, the fixed charges are the governing factor in the cost of power, and extra expenditures must be carefully considered, particularly so if fuel is cheap."

Mr. Archibald goes into the influence of the load-factor upon the cost of management and of distribution to some extent, and gives curves illustrating these costs for certain conditions. This matter, however, is not one which can be so fully discussed as the cost of production, and cannot be so definitely treated. The question of the influence of the load-factor upon the cost of electric energy to the consumer is also briefly considered, and this curve bears a fairly definite relation to the others.

The paper concludes with a discussion of the relative value of steam and gas power for the generation of electricity, showing the necessity for attention to details if the full advantage of the higher efficiency of the gas engine is to be attained in its commercial application.

THE ELECTRO-METALLURGY OF IRON ALLOYS.

RECENT DEVELOPMENTS IN THE PRODUCTION OF HIGH-GRADE ALLOY-STEELS IN THE ELECTRIC FURNACE.

V. Englehardt—Stahl und Eisen.

ALTHOUGH much has been said about the practicability of using the electric furnace for the smelting of iron and the refining of steel, it has been realized that the element of cost must, at the present time, prevent such methods from entering into general competition with the older processes. At the same time there is a field in which the electric furnace can be employed where the question of the cost of the product is secondary to its quality, and for such work the electric furnace possesses numerous advantages. In recent issues of *Stahl und Eisen* there is given an account, by Herr V. Englehardt, of the progress which has been made in the practical operation of the Kjellin process for producing high-grade alloy-steels in the electric furnace, and some abstract of these papers will be found of interest.

The experimental researches of Kjellin have been conducted since 1899 at the Gysinge Iron Works, situated on the Dalelf, about four hours by rail from Stockholm, in Sweden. These works operated a blast furnace, forge, and sulphite-cellulose works, this latter being the development of the facilities of the neighboring forest, and here in March, 1900, the first electric furnace, with a capacity for utilizing 78 kw. of electric energy, was put into active operation, turning out 270 kilogrammes of cast steel in 24 hours, with a consumption of about 7,000 kilowatt-hours of electric energy per metric ton of steel. This was soon improved by the production in a second furnace, of 600 to 700 kilogrammes of steel in 24 hours, with a consumption of 2,140 kilowatt-hours per ton. In July the cellulose works was destroyed by fire, and the energy that had been required for this portion of the establishment was diverted to the service of a third and still larger furnace, in which still more successful results have been obtained.

The Kjellin process is practically a reproduction of the crucible process of making steel by fusing the materials in such proportion as to give the required carbon content to the product without requiring any subsequent additions to the charge. The only differences are the substitution of electric methods of producing the required temperature, and the arrangement by which larger quantities can be handled than is practicable with the crucible process. Further, the Kjellin furnace is an induction apparatus, there being no contact of electrodes or any external parts with the charge, and hence there is no possibility for the introduction of any impurities, either solid or gaseous, so that the purity of the product is dependent entirely upon the purity of the material with which the furnace is charged.

The furnace itself is practically a step-down transformer, and the simplicity of its construction is marked. In an ordinary transformer the high-tension current passes through a coil of proper fineness, wound

about an iron core, while around this again is wound the coil of heavier wire in which the induced current is produced when an alternating current traverses the outer coil. In the case of the Kjellin furnace the outer coil is replaced by an annular channel, or sort of gutter, formed in the refractory material of the furnace, the wire coil and its iron core being in a central space so arranged that a free circulation of air is permitted. The charge of metal in the annular trough or gutter forms the short-circuited outer winding, so to speak, of the transformer, and the heat generated in the mass of the metal is employed to effect the fusion of the combination. It is evident that the capacity of the trough may be made sufficient to hold the charge required, and that this ring-like crucible may be kept closely covered during the entire operation, the completed run of steel being drawn off by a tap hole into a ladle and poured into moulds as desired.

The latest furnace of this type differs from the earlier ones in dimensions only, the simplicity and effectiveness of design having been such as to render no radical changes or modifications necessary.

From the records of the works it appears that the output of a furnace is about 5,000 kilogrammes of steel in 24 hours, the power required being 167.1 kilowatts, or about 222 electrical horse power, giving 4010 kilowatt-hours per day, or 802 kilowatt-hours per metric ton of steel. Records for another day show a better result, the consumption of electrical energy being 770 kilowatt-hours per ton.

Herr Englehardt gives a very complete thermal analysis of the working of the furnace, showing that the theoretical consumption of energy should be 489 kilowatt-hours per ton of steel, so that the above performances indicate an efficiency of more than 60 per cent. for the actual process.

The current at Gysinge is at present derived from water power, and under these conditions it is maintained by Kjellin that the highest grade of crucible steel can be made at a lower cost than by the crucible process. It is suggested also that such furnaces may well be operated in connection with blast furnaces, the electrical energy being obtained from the waste gases of the blast furnaces, used in gas engines, thus furnishing a method of utilizing the power in the gas in an allied line of work instead of using it to generate electric current to supply an outside market.

The Kjellin process has also been used to work with pig and ore as well as with pig and scrap, and the results have been encouraging when a high grade of ore is employed.

It is evident that the economy of the process is dependent almost entirely upon the cost of the electrical energy, and computations for one locality cannot therefore be used for another unless the comparative cost of current is known. Data for a large furnace, to consume 1,000 h. p. are given for a daily production of 30 to 36 tons, from which it is computed that steel can be made for about 70 marks per ton, but practical operations have not yet been carried out on such a large scale.

ELECTRIC POWER IN SHIPYARDS.

THE COMPARATIVE ADVANTAGES OF ISOLATED PLANTS AND CENTRAL STATIONS IN CONNECTION WITH THE USE OF ELECTRICITY IN SHIPYARDS.

J. F. C. Snell—North-East Coast Institution of Engineers and Shipbuilders.

AMONG the various classes of manufacturing and engineering establishments to which electric driving may be applied, there appears to be no one for which electricity appears to be better adapted than the shipyard. In nearly every instance the tools and machines are widely separated from each other and from the source of power, while the opportunities for employing portable and semi-portable tools are many and important. In existing yards the problem of power distribution has been partially solved by the use of a number of steam engines, either directly connected to the tools or arranged to drive groups of machines in the immediate vicinity, but this system involves the carrying of steam over long distances, and demands the placing of engines in exposed and unsuitable locations, while the substi-

tution of electric motors removes at once many of the power difficulties in this important department of engineering work.

In a paper recently presented before the North-East Coast Institution of Engineers and Shipbuilders by Mr. J. F. C. Snell, the application of electric power to industrial purposes in general and to shipbuilding establishments in particular, is discussed. Mr. Snell assumes that the desirability of using electric power is admitted, and that the principal question to be determined is simply the most desirable source from which the electric energy is to be obtained. In order to make an intelligent comparison between the relative advantages and costs of independent and co-operative generation of current, Mr. Snell gives first, in tabular form, the actual results of electrical stations operated by two large shipyards, one of which is partly driven by its own steam-driven plant, and partly from a town supply, while the other is supplied entirely from its own gas-engine driven plant. In these cases, allowing interest at 4 per cent. and depreciation at 5 per cent., the costs work out at 1.08d. per unit, or kilowatt-hour, for the first, and 1.173d. per unit for the second.

"The author has always contended that in works requiring from 300,000 to, say, 1,000,000 units per annum, and with a load factor of 20 to 30 per cent., the cost will be found to vary from 1.25d. per unit to 1d.; and he is of opinion that, looking at the question broadly and taking into due account an adequate depreciation of plant and average cost of upkeep for, say, a period of 20 years, 1d. is about the lowest limit for installations of the size stated He is aware, of course, that there are special cases in which, either through an abnormal and excellent load factor, or through the utilisation of blast-furnace gases, the cost is materially reduced below this figure. These, however, are quite the exceptions, and he affirms, without fear of contradiction, that the generality of installations will be found to have costs within the limits cited.

"As to the advantages of the works saving the capital expenditure; the responsibility involved in laying down their own plant, or the loss represented by the valuable space occupied; the incidental losses which result from having the machinery ready during many mornings in the year after holidays without the certainty of the men turning in, or during slack times; and the frequent special arrangements required to be made for working night shifts—all these items, which may be put to the credit of the outside power stations point of view, will be dealt with later in the paper.

"Now let us turn to the other side of the question, viz., supply to works from outside sources. Whether it be a power company like the Tyneside Power Company, or a municipal works such as Sunderland, what will be said will be true of most stations, and may be considered as generally applicable to all.

"The first and most obvious saving is in the capital outlay per kilowatt. Many independent plants do not exceed 200 kilowatts in extent, while the two power stations referred to have actually exceeded or are nearing 10,000 kilowatts. Now, if the smaller installation cost £45 per kilowatt installed —which figure includes buildings, boilers, engines, steam pipes, condensers, dynamos, and switchboards completely equipped on the one hand; or buildings and gas engines, water tanks, dynamos and switchboards completely equipped on the other hand, and also includes, for obvious purposes of safety, spare plant representing probably some 50 per cent. of the capacity of the running plant—it is obvious that the 10,000-kilowatt station, costing about £20 per kilowatt, can afford to spend money outside the station in laying adequate cables and fixing the necessary transforming machinery, and yet be able to effect a considerable saving on the capital sum.

"Secondly, it must be equally obvious that, while a decent load factor of anything between 15 and 35 per cent. even may be obtained in an independent installation, yet the combination of a dozen, and, *a fortiori*, several dozen such works in one station must result in a far better load factor, which is actually in practice found to be anything from 45 to 55 per cent. This improved load factor at the resultant station is owing to the non-synchronism of the various maximum demands on the several works, which among station engineers is known as the 'diversity factor.' This diversity factor really has a high value. The author knows examples where the resultant maximum load at a generating station is only some

60 per cent. of the integrated total of the maxima. This, obviously, means that a given amount of plant installed at the power station is able to deal with a much larger total of horse-power of motors installed in various works than the same plant could possibly deal with if it were split up into a number of small independent installations.

"As one is speaking to so many engineers who may not be specifically electrical, it would be well to define the term 'load factor,' as so much depends upon this, the most important detail after capital cost in producing economical results. The load factor of any plant, then, is the ratio of the actual units generated in any given time to the units which would be generated were the plant working continuously at full load during that time. For example: the number of hours in a year is 8760; an installation representing 100 kilowatts, working continuously for 8760 hours, would generate 876,000 units. If it is actually found that 219,000 units have been generated during the year, then the load factor of that plant has been $\frac{219{,}000 \times 100}{8760} = 25$ per cent.

"It must be clear to anyone that a steam dynamo of 100 kilowatts working continuously will cost less per kilowatt per annum than if only working more or less intermittently, or at varying loads, during a quarter of that time. Now, this is another of the advantages claimed for general sources of supply and is not based on mere hypothesis, but is actually proved from the results obtained, viz., the thereby increased load factor due to the supply given to several works, together with the practical diversity of their maximum loads, as before stated, enables the kilowatt or the horse power per hour—whichever basis be taken —to be more cheaply produced than if each works produced its own current."

By examining the costs of a large power station equipped with modern appliances, as well as the operative costs of various isolated plants, Mr. Snell obtained data from which he has plotted diagrams showing the relative prices of current supplied from a public station and from an isolated plant operated by the consumer. The results show that for a load factor below 50 per cent. there is a distinct gain in using the general supply station, while for load factors over 50 per cent. the isolated plant is the more economical. Since the character of the work done in shipyards is such that a load factor of 50 per cent. or more is not to be expected, 40 per cent. being as high as can well be attained, it appears that the power-supply station is the more desirable method.

Mr. Snell discusses the relative advantages of the direct and the polyphase current, and shows that notwithstanding the fact that the costs and weights of motors are in favor of the three-phase type the direct-current system has the advantages at present in point of efficiency, and appears likely to continue so for some time.

The subject of standardization comes in for discussion, and some very sensible advice in this connection is given.

"Wherever possible, it should be the aim to group the machinery and tools in such a way as to adopt three sizes of motor, and let us say, for example, 30 horse-power, 15 horse-power, and 5 horse-power. In this way a spare armature for each type of motor will probably be found to be sufficient, and thus the capital expenditure on spares will be considerably reduced.

"It is quite true that a complication ensues in many cases from the variety of speeds at which tools have to be driven, but the author does not think that this is as bad as is made out, and in special cases, rather than install a fourth size of motor, he would be inclined to modify the speed through gearing of some kind, even at the risk of some loss in efficiency Then, the starting switches, the switchboard panels, and instruments could be made, say, of two sizes to suit the three classes of motor, and thus there will be some system instead of the too frequent and too great variety of instruments one sees installed. In a system carefully laid out, the cables can also probably be arranged to be covered by two sections.

"The arc lamps should be, if possible, of the same pattern, and the resistance or choking coils in connection with them should be of precisely the same pattern. Thus a very simple and easily understood

system will be adopted with a resultant minimum first cost. If continuous current dynamos be installed, the adoption of the three sizes suggested can also be probably arranged; and the same size of carbon brush—though a different number of each, of course—can be utilised, and thus only one size of carbon be kept in stock.

"All electrical users having a number of motors will find it convenient to have a small portable blower as an auxiliary, mounted on a trolley, and by means of which the motors can be thoroughly blown out from time to time. It is advisable, of course, to have a totally enclosed motor, although rather more expensive in first cost for the same temperature limit. Yet, even in this case it is advisable occasionally to have them thoroughly blown out and freed from dust.

"One of the greatest difficulties which manufacturers have is to ascertain the size of motor to attach certain machines. In any case, with direct current installations it is always advisable to have the motors compound wound, and in cases of intermittent work, such as with punching and shearing machines, as an extreme example, it is necessary to supplement the motor by a heavy fly-wheel. These are points, however, upon which it is advisable to get expert advice, and to enter into a discussion of the sizes of motors for various industries would require a paper in itself."

THE OSMIUM ELECTRIC LAMP.

PRACTICAL RESULTS WITH THE IMPROVED WELSBACH INCANDESCENT ELECTRIC LAMP WITH OSMIUM FILAMENT.

Fritz Blau—Elektrotechnische Zeitschrift.

WE noticed in these columns last month the improved tantalum incandescent electric lamp recently perfected through the labors of Dr. von Bolton and Dr. Feuerlein. We now have a paper by Herr Fritz Blau presented before the Elektrotechnische Verein in Berlin, and published in a recent issue of the *Elektrotechnische Zeitschrift*, giving an account of the progress which has been made with the osmium lamp of Dr. Auer von Welsbach, already well known by reason of his invention of the incandescent gas mantle.

Herr Blau calls attention to the fact that before succes was attained with the carbon filament for incandescent electric lighting experiments were made with drawn platinum wire, but that this material failed to give sufficient durability, and was wholly displaced by carbon.

Of late years attempts have been made to find some material which would stand a higher temperature than the carbon filament, and enable a better efficiency and a higher illuminating power to be obtained. According to the so-called law of Stefan the total amount of energy radiated by a heated body is proportional to the fourth power of the absolute temperature. Increase in temperature also causes a rapid increase in the proportion of short waves as compared with long waves, this rate being stated by Herr Blau to increase with the fifth power of the temperature. The increase in proportion of short waves is much more rapid for bodies with a smooth metallic lustre than for black bodies, and hence it is evident that the improvement in the efficiency in incandescent lamps depends upon the use of a metallic filament in place of carbon. Among the metals available for the purpose only tantalum and osmium appear to offer practical possibilities. The results which have been obtained with tantalum we have already noticed, while the paper of Herr Blau shows how the difficulties encountered in the employment of osmium have been largely overcome.

Dr. von Welsbach found that it was impossible to draw metallic osmium in the form of wire, on account of the brittleness of the metal, and he therefore attempted to coat a fine platinum wire with osmium and then to evaporate the platinum, leaving the osmium behind. Practical difficulties were encountered with this process, principally owing to the formation of a fusible platinum-osmium alloy, and a new process had to be devised. This process consisted in the formation of a paste consisting of finely powdered osmium with an organic binder,

the mixture being forced through a die to form a filament, subsequently dried and carbonized. The dried filament was then subject to the process of forming, which consists in placing the porous filament, which contains a large proportion of carbon, in a vessel containing vapor of water, together with a certain proportion of reducing gases. Here the filament is heated to incandescence by the passage of an electric current, the result being the repetition, on a small scale, of the well-known process for the production of water gas. The steam is dissociated to oxygen and hydrogen, and the carbon is removed by conversion into carbon monoxide and dioxide, while the hydrogen converts the crude osmium into a metallic filament, practically pure, although still somewhat porous, the surface being somewhat rough. The ends of the filament are then fused by the electric arc to platinum terminals and enclosed in a bulb from which the air is exhausted, similar in general appearance to the carbon-film lamp.

The early lamps could stand only a low voltage, the first on the market being made for 37 volts, but more recently lamps of higher voltage, up to 110 volts have been perfected. The filament of a 37 volt lamp, of 25 Hefner candle-power, is about 280 millimetres long, and is arranged in four loops, the diameter of the filament being 0.087 millimetre. Such a lamp has a life of 5,000 hours, but the useful life may be taken at about 2,000 hours, during which time the illuminating power does fall more than 20 per cent. from the original. Since the resistance increases with the temperature, an increase in voltage of 10 per cent. gives an increase of only 6.5 per cent. in current, while for the ordinary carbon filament the current increase is 12 per cent. The corresponding increase in illumination for the osmium lamp is about 40 per cent. and for the carbon lamp 80 per cent., so that changes in the voltage have a smaller effect upon the light with the osmium than with the carbon lamp.

Apart from the longer life, the osmium lamp is nearly double the efficiency of the carbon lamp, the consumption of energy being about 1.5 watts per candle, as against 3 watts per candle for the carbon lamp. It will therefore be possible, simply by a change of lamps, to secure double the light from the same consumption of current, a feature which should cause a rapid introduction of the new lamp, and a large increase in the employment of electric lighting.

As at present constructed, the osmium lamp is rather more fragile than the carbon lamp, but the difference is slight, and the lamps appear to stand the shocks and vibrations of railway service well.

The activity which has appeared of late in the improvement of incandescent electric lighting is most encouraging. For many years the carbon lamp was used without any material improvement in efficiency or illumination being afforded. Then came the Nernst lamp, followed by the osmium and the tantalum lamps, and should any of these newcomers fulfil their present promise some improvement in the carbon lamp must be made if it is to stand against the superior advantages of its later rivals. So far the improvements have all come from Germany, although other countries have not been slow to take up with the new devices, but the present stimulus should be sufficiently powerful to bring out other improvements elsewhere.

ELECTRICITY AND ENGINEERING.

AN ADDRESS TO STUDENTS UPON THE VALUE TO ENGINEERS OF THE STUDY OF THE THEORY OF ELECTRICITY.

James Swinburne—Institution of Civil Engineers.

IT is now very generally agreed that theory is not to be despised as an aid to the conduct of practical work, and the ancient prejudice against the man who really tried to find out the fundamental principles of the art he endeavored to follow for a livelihood is beginning to die out. This state of affairs accounts for the fact that instruction to young men, students and others, in the theory of the various branches of engineering which they propose to enter is now looked upon with approbation, and

considered as really of value to them as a portion of their preparation for practical life.

An interesting example of the valuable instruction now given to students by men who have attained high reputations in engineering work is found in the address recently delivered to the student members of the Institution of Civil Engineers by Mr. James Swinburne, treating of the theory of electricity and the value of its study to engineers.

Mr. Swinburne discusses first the subject of mathematics, and its importance as a foundation, and makes some excellent points as to the fact that mathematics should be regarded only as an instrument of value in proportion as it is applied to useful work. The present methods of teaching mathematics have come down from the time when it was dealt with as an abstract study, rather degraded than otherwise by being put to any practical application, but it is undoubtedly much better to learn mathematics by studying mathematical physics, using the text books rather as commentaries. Under the older methods the mathematician is strongly tempted to make the data of his problems fit the limitations of his mathematics, while in engineering the data have an annoying manner of declining to stay neglected, and the computed results must always stand the test of inflexible comparison with the completed work. At the present time, unfortunately, the applications of some of the mathematical methods most useful in electrical work, such as the vectorial analysis, are impeded by minor differences in notation, which Mr. Swinburne rightly suggests might well be referred for standardization to a committee of competent mathematicians, such as the committee of the British Association.

Apart from the study of the theory of electricity as an application of mathematics, the practical experience gained in the use of the centimetre-gramme-second system is of much value. In this connection, Mr. Swinburne makes some characteristic comments upon the rival systems of measurement.

"I will not attempt to discuss the commercial or technical aspects of the rival claims of the decimal and vulgar fraction; of the metre and the inch, as standards of length; or of the derivation of other units from those of length, mass and time on the one hand, or from independent standards, as in popular use. The three questions are totally distinct, but they are generally discussed as if they were all one. For unapplied scientific work it is of enormous advantage to adapt the decimal system, and the derivation of other units from those of length, time and mass. What are chosen as units of length, time and mass is unimportant. The metre, second and gramme are purely arbitrary choices. The metre is not a round decimal fraction of anything in particular. The second is not a round decimal of a day or year, and the gramme involves water which is not more standard than anything else. This matters little; the "C.G.S." system is invaluable in scientific work, and electricians have developed it infinitely more than any one else, and electrical engineering is the only industry in which the system is really used. It is enormously difficult to get a systematic and satisfactory system of units, and even electricians have got into some confusion. For one thing they got their standard ohm and volt more than 1 per cent. wrong, and the alteration was expensive and troublesome.

"I will now pass from the mathematics of electrical physics to the physical ideas at the base of electrical theory. During the last few years a profound change has come over the face of the physics of ultimate matter, owing to the advent of the electron hypothesis. Matter is supposed to be made up of molecules, which are composed of atoms. The atoms contain very much smaller bodies called electrons, each consisting of a minute particle of matter charged with a definite quantity of electricity, or consisting of the charge of electricity without the matter. Some regard the existence of electrons as a sort of theological dogma, others as a statement of fact, others as a sound theory, others as a working hypothesis, and many more as a curious speculation. But there is no doubt that the idea is of far-reaching importance. The vital point for us is that, like molecules, atoms, and ether, the electron is an invaluable aid to thinking straight. Whatever else it may be matters little. But it is by no means merely electrically that it is of importance; it involves a more or less complete recon-

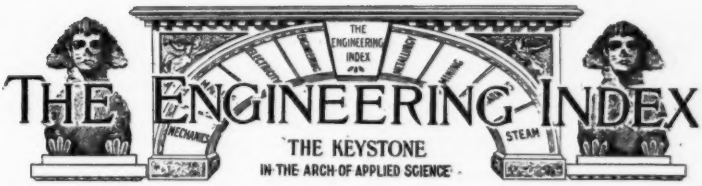
struction of our ordinary conceptions of the ultimate constitution of matter. Electricity bids fair to become the sovereign physical science, mechanics, heat, light, and chemistry being vassal subjects. Nothing I can say would therefore be an exaggeration as to the importance of the study of the new theory of the universe. The only difficulty at present is that the subject is so new that there is a want of books which give any clear account of it. What is urgently needed is a treatise which begins by assuming the existence of electrons, and gives a clear account of what the author conceives them to be, and then goes on to explain how they explain phenomena, and unravel all sorts of tangles, and open all sorts of strange doors of which the hypothesis is the unexpected master-key.

"So far, except in the case of the theory of electrons, I have been dealing with the indirect advantages of studying the theory of electricity; but before I come to the direct advantages, I must call attention to a feature of electrical engineering. It is an industry of exact calculation, and of exact measurement. To make accurate measurements, accurate standards and accurate means of comparison are needed. The electrical engineer is singularly badly off in the matter of standards. The standard of resistance is the most permanent, and it might be supposed that nothing is easier than to make and adjust a resistance-coil that would remain the same for all time. Perhaps the chief difficulty arises because electricians generally use alloys. Pure materials vary in resistance with temperature, and they are put on one side in favour of alloys which have small temperature-coefficients and high specific resistance. Such specific resistance is not really at all important. Many alloys undergo gradual internal changes, and a very slight change may make a very considerable variation in the specific resistance. The theory of alloys may put us in possession of resistance standards that will not vary; at present it is well known that certain alloys are by no means in a state of internal equlibrium, so that they go on slowly altering spontaneously. The standard of electrical pressure is a cell which has to be made up according to prescription. Each experimenter uses his own prescription. If a committee were formed to try one another's prescriptions it might be possible to select one as a standard. The other standards can be derived from those of resistance, pressure, and time. It is clear that the electrical industry is rather unfortunate in the matter of standards, compared with mechanical engineering, which has its standards of length and weight which are practically interchangeable and easily copied."

The development of electrical engineering has been of immense value to other departments of engineering work, especially in the ability to make precise and reliable measurements of quantities previously very difficult to handle. In the transmission of power by shafting, pulleys, and belts or ropes, the losses were both large and indeterminate. With electrical transmission the losses have been greatly reduced, and are in any case capable of very accurate competition beforehand.

The measurement of power developed by a steam engine may be made by the use of the indicator, but this involves many sources of error, and does not include the internal losses in the engine itself. If, however, the engine is used to drive a dynamo, the output can be determined very readily and accurately, while the input of steam can be readily measured, the efficiency of the whole plant being thus obtainable. Again, the use of the electric motor enables the power consumed by the machines driven to be measured with ease and accuracy, and the resulting information has been of immense value in the improvement and development of machine tools and processes.

Mr. Swinburne enumerates many useful applications of electricity, these serving largely as examples of his contention that a knowledge of the theory and practice of this important department of engineering work is of great value to the student and engineer in every department of practice. In power transmission, in mining, in electric-chemistry and metallurgy, and in nearly every department of work electricity is of great importance, and there is no doubt that: "a modern engineer cannot consider his technical equipment complete without some knowledge of the theory of electricity."



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch Repairs.

Description of the Method of Repairing an Arch of 12 Metres Span (Notice Explicative sur la Méthode Suivie pour Réparer un Pont de 12 Metres d'Ouverture). M. Jouvion. Describing the manner of injecting mortar into the joints of an arch which had become weakened by the settling of an abutment. 1200 w. Revue Technique—Feb. 25, 1905. No. 68428 D.

Blackwell's Island.

The Erection of the Blackwell's Island Bridge. An illustrated detailed description of this bridge from East 59th St., Manhattan, over Blackwell's Island to Ravenswood, and the methods of erection. 2500 w. Eng Rec—March 4, 1905. Serial. 1s part. No. 68182.

Brooklyn Bridge.

A Study of the Brooklyn Bridge Problem. Edward Whitehead Curtiss. Illustrates a system of transportation for re-

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ducing the load on the bridge and distributing it more uniformly and overcoming the congestion at the terminal. 1500 w. Sci Am—March 18, 1905. No. 68327.

Concrete Arches.

New Concrete Arches on the Lake Shore & Michigan Southern Railway. Illustrates and describes the bridge over Chagrin River, at Willoughby, Ohio; and the bridge at Angola, N. Y. 1200 w. Ry Age—March 24, 1905. No. 68670.

Erection.

The Erection of the Missouri River Bridge at Plattsmouth, Neb. F. T. Darrow. Illustrates and describes the method of erecting a renewed bridge 1,658 ft. long, on the C. B. & Q. system, without interrupting traffic. 3500 w. Eng Rec—March 4, 1905. No. 68184.

The Erection of the Quebec Bridge. An illustrated description of the longest span bridge undertaken in any country. 5200 w. Eng Rec—March 4, 1905. No. 68194.

Expansion.

Methods of Expansion of Railway Bridges. Francis S. Rice. Outlines a few of the methods providing for temperature changes and expansion in railway bridges. Brief discussion. 2000 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68572 D.

Floors.

Cushioned Floor Beds for Railroad Bridges. Gives experience in the use of granulated cinder. General discussion. 2200 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68573 D.

The Abandonment of Wooden Floors for Suspension Bridges (La Suppression du Bois dans les Tabliers des Ponts Suspendus Modernes). G. Leinekugel Le-Cocq. Data and results of experiments showing the superiority of reinforced-concrete floors over wood. 2000 w. Génie Civil—Feb. 18, 1905 No. 68413 D.

Holland.

The Bridge over the Maas at Spijkenisse (Le Brug over de Oude Maas nabji Spijkenisse). A. L. de Gelder. Illustrating and describing a new railroad bridge with three through trusses of 83.7 metres span, and one draw span with openings of 25 metres. 3000 w. De Ingenieur—Feb. 18, 1905. No. 68708 D.

Piers.

Construction of the Thebes Bridge Piers. Illustrated description of the construction of the piers for a long bridge across the Mississippi River at Thebes. 1400 w. Eng Rec—March 4, 1904. No. 68191.

Reconstructing Piers of a Railroad Bridge in Service. Illustrates and describes a difficult piece of substructure work involving the replacing of two piers and repairing one abutment of a railroad bridge under traffic, at Terre Haute, Ind. 2500 w. Eng Rec—March 4, 1905. No. 68188.

See also Civil Engineering, Construction.

Plate Girders.

Plate Girder Webs. States briefly the difficulties in forming a really satisfactory formula, and gives reasons for adopting the one selected. 5300 w. Engr, Lond—March 17, 1905. No. 68666 A.

The Reconstruction of the Baltimore and Ohio Railroad Bridge Over the Ohio River, at Benwood, West Virginia. J. E. Greiner. Describes the old bridge, and the reconstruction, which was done in sections, extending over a number of years. 3 plates and ills. 2200 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68575 E.

Reinforced Concrete.

Reinforced Concrete Piers of the Gilbertsville Bridge. Illustrated description of piers 60 to 71 ft. high from bottom of footing to top of coping. 800 w. Eng Rec—March 4, 1905. No. 68192.

See also Civil Engineering, Materials of Construction.

Standard Bridges.

Standard Bridges on the Harriman Lines. Complete specifications, plans, &c., with explanatory remarks. 4500 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68375.

Suspension.

A Note on Early American Suspension Bridges. Notes aiming to fix as definitely as possible the claims of certain inventors in connection with the first introduction of suspension bridges. 1500 w. Eng News—March 16, 1905. No. 68335.

A Rational Form of Stiffened Suspension Bridge. J. Melon. Continued discussion of paper by Gustav Lindenthal, on this subject. 1500 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68576 E.

The Monongahela River Suspension Bridge at Morgantown, W. Va. W. H. Boughton. Illustrated account of a bridge similar to the one that failed recently at Charleston, W. Va., and about the same age, which is not considered entirely safe. 1100 w. Eng News—March 9, 1905. No. 68275.

Swing Bridge.

A New Swing Bridge at Copenhagen, Denmark. H. C. V. Moeller. Illustrated detailed description of a combined highway and double-track railway bridge, consisting of one center-bearing draw span

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and six deck plate-girder spans, with one roadway and two sidewalks. 2500 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68574 E.

Viaducts.

The Erection of the Kentucky River Viaduct in 1877. Joseph H. Springer, Sr. Outlines briefly the methods adopted in constructing this structure, which carries the Cincinnati Southern Ry. across the Kentucky River. Ills. 2400 w. Eng News—March 23, 1905. No. 68586.

The Reconstruction of the Portage Viaduct. Illustrated explanation of the method of reconstruction without interrupting traffic. 2200 w. Eng Rec—March 4, 1905. No. 68187.

The Viaduct of Fades. Emile Guarini. Illustrates and describes some interesting features of a great viaduct, having a length of 1,446 ft. being constructed in the south of France. It is remarkable not only for its dimensions, but for the original arrangements. 1800 w. Sci Am Sup—March 4, 1905. No. 68120.

Viaduct across the Seine at Paris (Viaduc sur la Seine à Paris). An illustrated description of the new bridge across the Seine above the Austerlitz bridge, for the Paris Metropolitain. 1800 w. 1 plate. Revue Industrielle—Feb. 25, 1905. No. 68717 D.

Washington, D. C.

Connecticut Avenue Bridge, Washington, D. C. An illustrated article showing the progress made on this structure during the past year, the methods of construction, etc. 1000 w. Ry Age—March 24, 1905. No. 68675.

CONSTRUCTION.

Acoustics.

The Acoustics of Public Halls and an Instrument for Investigation (Ueber die Akustik von Hörsälen und ein Instrument sie zu Bestimmen). Sigm. Exner. A study of the distribution of sound and the production of echoes and interference in public auditoriums. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—March 10, 1905. No. 68462 D.

Bins.

Determining the Capacity of a Cylindrical Grain Bin with Eccentric Conical Hopper. B. F. Groat. Gives a general formula and method. 600 w. Eng News—March 9, 1905. No. 68279.

Building Construction.

Steel Work in the New York Hippodrome. Illustrates and describes this feature in the construction of this large fireproof building for amusement purposes. 2000 w. Eng Rec—March 25, 1905. No. 68630.

The Construction of the Farmers' Bank Building, Pittsburg. An illustrated description of rapid building operations. A 24-story steel-cage office building with basement and sub-basement was erected and occupied in less than one year. 2400 w. Eng Rec—March 18, 1905. No. 68396.

The New Times Building. Illustrated detailed description of the design and construction. 4000 w. Archts & B'ldrs' Mag—March, 1905. No. 68296 C.

The New York Hippodrome. Illustrated description of the largest building of its kind in the world, recently built in New York. Principally describes the mechanical features of the stage. The building seats 5,300. 1800 w. Sci Am—March 25, 1905. No. 68597.

Cofferdam.

Sheet Pile and Canvas Cofferdam for a Large Concrete Pier. J. C. Hain. An illustrated article describing conditions and the methods used. 1400 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68377.

Concrete Piles.

Concrete Piles at the United States Naval Academy. Walter R. Harper. Illustrates and describes foundation work of the academic building at Annapolis, Md. 2400 w. Eng Rec—March 4, 1905. No. 68196.

Dam.

Completing the New Croton Dam. An illustrated description of methods of closing the river tunnel which had been left to provide for the passage of the normal flow of the Croton River. 3200 w. Eng Rec—March 4, 1905. No. 68195.

Embankments.

Concrete and Puddle for Reservoir Embankments. William Watts. Information on the use of concrete for this purpose, the comparative cost of puddle and concrete trenches, the mixing, &c. 4000 w. Cement—March, 1905. No. 68609.

Excavating.

A New Style of Scraper Excavator. Illustrates and describes an excavator consisting of a scraper or bucket of special design, handled by a derrick mounted upon a car or scow. 600 w. Eng News—March 2, 1905. No. 68110.

Modern Machinery and the Panama Canal. A. W. Robinson. Mr. Robinson's first article deals with methods and costs of previous works, discussing the extent to which they can safely be used as guides for the work at Panama. 3500 w. Engineering Magazine—April, 1905. No. 68720 B.

Fireproofing.

An Important Test of Fireproof Construction. Gives the official report of Prof. Ira H. Woolson of a test made in

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a Pittsburg warehouse. Ills. 1800 w. Br Build—Feb., 1905. No. 68153 D.

Two Interesting Examples of Fireproof Construction. Brief illustrated descriptions of double houses lately built in Pittsburg; and the Campania apartments, built in Akron, Ohio. 1000 w. Br Build—Feb., 1905. No. 68154 D.

Foundations.

The Foundations for the Hotel Albert, New York. Describes difficult foundation work, because of quicksands encountered in building an extension to this hotel. Ills. 2000 w. Eng Rec—March 11, 1905. No. 68266.

Galveston.

Raising the Grade of Galveston. Map, with description of unusual hydraulic dredging and filling work. 2200 w. Eng Rec—March 11, 1905. No. 68263.

Masonry.

Masonry. Abstract of report at meeting of the Am. Main. of Way Assn. On the use of concrete and reinforced concrete, its adaptability, specifications for cement, &c., with discussion. 8500 w. Ry Age—March 24, 1905. No. 68682.

Mill Construction.

The Underwriters' View of Some Failures of Construction. F. Elliot Cabot. Read before the Boston Soc. of Archts. Discusses the weaknesses in mill construction, and fireproof construction. 2000 w. Am Archt—Feb. 25, 1905. No. 68070.

Pillars.

Recent Studies and Experiments on the Resistance of Pillars (Neue Studien und Versuche über die Tragkraft der Säulen). Prof. Bernhard Kirsch. A comparison of the formulas for the buckling of columns with experiments on small rods in the testing machine. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 17, 1905. No. 68458 D.

Race Course.

Engineering Features of Belmont Park. General plan and description of interesting engineering features of a fine race course near New York. Ills. 3300 w. Eng Rec—March 11, 1905. No. 68268.

See Civil Engineering, Materials of Construction.

Roof Trusses.

The Erection of the New York Hippodrome Roof Trusses. Illustrates and describes the method of erection by means of a special timber tower and its booms. 1200 w. Eng Rec—March 18, 1905. No. 68398.

Simplon Tunnel.

Hydraulic Rock-Borer. An illustrated detailed description of the Brandt hydraulic rock drill, the principal machine employed in boring the Simplon Tunnel. 1300 w. Engr, Lond—Feb. 24, 1905. No. 68224 A.

The Completion of the Simplon Tunnel. Charles R. King. The first of a series of extensively illustrated articles. The present number deals principally with the difficulties due to encountering hot springs. 2500 w. Sci Am Sup—March 25, 1905. Serial. 1st part. No. 68599.

The History of the Simplon Undertaking (Zur Geschichte des Simplon-Unternehmen). S. Pestalozzi. A general history of the various projects which resulted in the boring of the Simplon tunnel. Serial. Part I. 1800 w. Schweiz Bauzeitung—March 4, 1905. No. 68498 B.

The Perforation of the Simplon (Il Traforo del Sempione). A comprehensive review of the Simplon tunnel works, in connection with the announcement of the meeting of the headings. 3000 w. L'Industria—March 12, 1905. No. 68712 D.

The Piercing of the Simplon (Il Traforo del Sempione). N. Sacerdoti. A review of the undertaking in view of the completion of the perforation, with comments on the salient features of the work. 1800 w. Il Monitore Tecnico—Feb. 28, 1905. No. 68711 D.

The Simplon Tunnel. Editorial review of this great engineering work, its difficulties and interesting features. 3500 w. Engng—Feb. 24, 1905. No. 68222 A.

The Simplon Tunnel. The first of a series of articles describing the difficulties encountered and overcome, especially those due to the influx of large quantities of hot water. 2800 w. Engr, Lond—March 3, 1905. Serial. 1st part. No. 68315 A.

Subways.

See Civil Engineering, Municipal.

Tunnels.

Reinforced Concrete Tunnel on the Southern. Illustrated detailed description of the construction of a tunnel at South Knoxville, Tenn. 450 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68368.

Some Proposed Alpine Tunnels. Information, with map, concerning a new railway line from Genoa to Paris, and the tunnels that would have to be bored. Also a route from Genoa to Tartona, with the Rigoroso tunnel. 1600 w. Engr, Lond—March 17, 1905. No. 68668 A.

See also Simplon Tunnel.

MATERIALS OF CONSTRUCTION.

Brick.

Paving Brick, Testing and Inspection. Arthur N. Talbot. Read before the Illinois Clay Workers' Assn. Considers requirements and tests, some of the meth-

ods used for different grades of brick, &c. 2800 w. Munic Engng—March, 1905. No. 68351 C.

Cement.

British Standard Specifications for Portland Cement. Gives the specifications recently adopted by the Committee on Cement of the Engineering Standards Committee of Great Britain. 1500 w. Eng News—March 2, 1905. No. 68117.

Disintegration of Portland Cement Briquettes by Oil and Experiments to Prevent It. James C. Hain. A report of experimental investigations and the results. Ills. 4000 w. Eng News—March 16, 1905. No. 68339.

Review of an Article by Eduard Jordis and Erhard H. Kanter, on the Historical Development of the Theories Concerning the Constitution of Portland Cement. Published in the *Zeitschrift für Angewandte Chemie*, Berlin. 3300 w. Cement Age—Feb., 1905. Serial. 1st part. No. 68083.

Slag and Portland Cements (Ueber Schlacken und Eisen-Portlandzement). Fritz Hromatka. A comparison of the properties of slag cement with those of the so-called "iron" Portland cement and ordinary Portland cement, discussing their respective applications. 3500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 25, 1905. No. 68707 D.

The Development of the Portland Cement Industry in the United States (Die Herstellung von Portlandzement in den Vereinigten Staaten von Amerika). A. Heller. With plans of recent works and details of the equipment. 3000 w. Zeitschr d Ver Deutscher Ing—March 11, 1905. No. 68445 D.

Cement Works.

The National Portland Cement Works, Martin's Creek, Pa. Begins an illustrated detailed description of works of unusual interest in several respects. 2500 w. Eng Rec—March 11, 1905. Serial. 1st part. No. 68264.

Clays.

The Useful Properties of Clays. Allerton S. Cushman. The present article considers the formation of clays, and the kinds; their plasticity, binding power, tensile strength, slaking, and air shrinkage. 3000 w. Brick—March, 1905. Serial. 1st part. No. 68295.

Concrete.

Safeguards for Laying Concrete in Frosty Weather. Describes methods used in constructing large buildings of reinforced concrete near Rochester, N. Y., in winter weather. 2000 w. Eng Rec—March 4, 1905. No. 68185.

The Cost of Concrete Deposited in Molds Under Water for a Pier at Superior Entry, Wis. Abstract from the report of the Chief of Engineers, U. S. A., giving the methods and cost of building the concrete south pier, 3,023 ft. long. Ill. 2000 w. Eng News—March 2, 1905. No. 68118.

Preservatives.

Preservatives for Stone Walls. F. S. Hardesty. Discusses the cause of dampness and decay, and various processes for preserving walls of stone, brick, or concrete. 2500 w. Ice & Refrig—March, 1905. No. 68179 C.

Reinforced Concrete.

Aims and Scope of Laboratory Tests of Reinforced Concrete. Prof. F. H. Constant. An account of aims and methods and the work being accomplished. 4500 w. Munic Engng—March, 1905. No. 68354 C.

Concrete-Steel Construction. C. A. P. Turner. An illustrated article considering the action of concrete with steel, the function of each in the combination, the problems presented by beams, slabs and columns separately, and the mixture of concrete, and the cost. 1800 w. Jour Assn of Engng Socs—Feb., 1905. No. 68685 C.

Construction of the Schuylerville Concrete Dam and Power House. Illustrated detailed description of the construction of a two-story power house and pulp mill with concrete floors and walls and steel beams and columns, five steel and concrete penstocks, a hollow dam, abutments, wing walls and bulkheads. 1500 w. Eng Rec—March 4, 1905. No. 68193.

Description of Concrete-Steel Water Tower and Standpipe at Fort Revere, Hull, Mass. Leonard S. Doten. Read before the N. E. W.-Wks. Assn. Illustrates and describes this structure, constructed by the Government in connection with the water supply system for this military post. 1800 w. Cement Age—Feb., 1905. No. 68082.

Economical Construction of Reinforced Concrete Beams and Floor Slabs. Charles R. Steiner. Gives a table, submitted as a fair review of the most suitable sizes for varying maximum moments, with explanatory notes. 800 w. Eng News—March 9, 1905. No. 68280.

Experiments on Reinforced Concrete Pipes Made for the U. S. Reclamation Service. J. H. Quinton. An illustrated account of experiments made at Los Angeles, Cal., to determine if a more durable material than steel or wood could be used to carry water in pressure pipes across long depressions on canal lines. 1300 w. Eng News—March 9, 1905. No. 68273.

We supply copies of these articles. See page 319.

High Reinforced Concrete Retaining Wall Construction at Seattle, Wash. C. F. Graff. Illustrates and describes the methods of design and construction. 2200 w. Eng News—March 9, 1905. No. 68281.

Masonic Temple of Reinforced Concrete Construction at Toledo, O. Illustrated detailed description. 1200 w. Eng News—March 16, 1905. No. 68340.

On the Question of Concrete and Imbedded Metal (Subject IV. for Discussion at the Seventh Session of the Railway Congress). J. F. Wallace. Report (No. 3) for America. 32000 w. 10 tables and figs. Bul Int Ry Cong—Feb., 1905. No. 68382 E.

On the Question of Concrete and Imbedded Metal (Subject IV. for Discussion at the Seventh Session of the Railway Congress). W. Ast. Report (No. 2) for all countries except America and Russia. 22400 w. 4 tables and figs. Bul Int Ry Cong—Feb., 1905. No. 68381 E.

On the Question of Concrete and Imbedded Metal (Subject IV. for Discussion at the Seventh Session of the Railway Congress). Serge de Kareischa. Report for Russia. 18300 w. 10 tables. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68621 E.

Reinforced Concrete Medical Laboratory: Brooklyn Navy Yard. Illustrated description of this building. The walls are of brick, the floors, interior columns and roof of reinforced concrete. 1400 w. Eng News—March 23, 1905. No. 68585.

The Construction of the Steel-Concrete Shops at Beverly, Mass. Illustrated detailed description of the construction of buildings for the new plant of the United Shoe Machinery Co. 3000 w. Eng Rec—March 4, 1905. No. 68189.

The Design of Reinforced Concrete Beams from the Economic Point of View. Translation of an article by E. Elwitz, published in *Beton und Eisen*, on the design of rectangular and tee-shaped reinforced-concrete beams, arranging the formulas so as to facilitate, by the aid of tables, the most economic arrangement of proportions. 2000 w. Cement—March, 1905. Serial. 1st part. No. 68608.

The Robert Gair Reinforced-Concrete Factory and Warehouse. Illustrated description of a building under construction in Brooklyn, N. Y. 1400 w. Eng Rec—March 4, 1905. No. 68197.

Visintini Reinforced Concrete Construction, Textile Machine Works, Reading, Pa. Leon S. Moisseiff. Illustrated description of a four-story building nearing completion for The Textile Machine Works, of Reading, Pa., on a system used for the first time in this country. 2200 w. Eng News—March 2, 1905. No. 68111.

See also Civil Engineering, Bridges.

Reinforcement Rods.

Waved-Iron Bars (Welleneisen). Alexander Sattman. Describing an improved form of rod with corrugated ribs, especially adapted for use in reinforced concrete, by reason of the impossibility of slippage. 1200 w. Stahl u Eisen—March 1, 1905. No. 68441 D.

Specifications.

Recent Work in Unifying Specifications for Engineering Materials. J. Parker Snow. An account of the work being done on these lines in this and other countries. 800 w. Jour Assn Engng Soc's—Jan., 1905. No. 68349 C.

Timber.

Some Common Defects in Timber and Their Causes. Harold Busbridge, in *Technics*. The present article deals exclusively with those essential parts of a tree which are generally looked upon as blemishes by those who use the timber for structural purposes. Ills. 2800 w. Sci Am Sup—March 25, 1905. No. 68600.

MEASUREMENT.

Loading.

New Data on the Weight of a Crowd of People. Lewis J. Johnson. An account of experimental investigations, with illustrations, proving that the weight often reaches above 150 lbs. per sq. ft. 1800 w. Jour Assn Engng Soc's—Jan., 1905. No. 68348 C.

Photo-Surveying.

The Rapid Preparation of a Topographical Map by the Aid of Photography (Sur Une Carte Topographique d'une Assez Grande Etendue Levée en tres Peu de Temps à l'Aide de la Photographie). A. Laussedat. Describing important photo-surveying work about Mount Argaeus, in Asia Minor. 2000 w. Comptes Rendus—Feb. 13, 1905. No. 68419 D.

Stream Gaging.

River Discharge, Mean Velocity, and Cross-Sectional Area Curves. F. W. Hanna. Abstracted from a paper presented at the Hydrographic Conference of the U. S. Geol. Survey. Explains methods of obtaining these curves. 1800 w. Eng News—March 23, 1905. No. 68581.

Theodolite.

A Special Theodolite for Tunnel Cross-Sections and General Tachymetry. Illustrated description of an instrument that has been used extensively in taking cross-sections of the Simplon tunnel. 1200 w. Eng News—March 2, 1905. No. 68112.

MUNICIPAL.

Boulevard.

The Construction of Section 2, River-

side Drive Extension, New York. An illustrated article giving information of this drive between 135th St. and 145th St. 1500 w. Eng Rec—March 25, 1905. No. 68628.

Macadam.

Cost of Maintaining Macadam Streets. Gives some definite figures as to cost, and a statement of the condition of the streets at Pawtucket, R. I. Ills. 1500 w. Munic Engng—March, 1905. No. 68353 C.

Pavements.

Brick Pavements for Villages. Le Grand Brown. The first of a series of articles on street pavements in small towns. The present number gives an illustrated description of the street improvements in Canandaigua, N. Y. 1600 w. Munic Jour & Engr—March, 1905. No. 68257 C.

Joint Fillers for Brick Pavements. Ira O. Baker. Read before the Illinois Clay Workers' Assn. Considers sand, tar, asphalt, and cement as fillers, favoring the last. 2400 w. Munic Engng—March, 1905. No. 68352 C.

Roads.

Oiled Roads of California. Extracts from a recently issued bulletin, with photographs showing the conditions of the roads and samples of work. 3500 w. Munic Engng—March, 1905. No. 68350 C.

Secrets of the Good Roads of France. William Ballantine. Considers methods of construction, materials, repairs, maintenance, traffic, &c. 2700 w. Automobile—March 11 1905. No. 68254.

Sewage Disposal.

The Sewage Disposal Works at Saratoga, N. Y. F. A. Barbour. Explains the conditions to be met, and gives an illustrated detailed description of the plant and its construction. It includes a new main sewer, the building of a small pump well and pumping station, the lifting of the sewage 15 feet by centrifugal pumps, the laying of a 9,000 foot force main, the building of a septic tank of 1,000,000 gals. capacity, and the construction of 18 acres of sand filters. 9500 w. Jour Assn of Engng Socs—Feb., 1905. No. 68684 C.

Sewers.

A Traveling Form for Constructing the Invert of Concrete Sewers. Robert R. Evans. Illustrated description, giving information in regard to its use, advantages and cost of work where it was used. 2000 w. Eng News—March 9, 1905. No. 68278.

Construction of Part of the Intercepting Sewers of Chicago. W. A. Shaw considers the section lying east of the Illinois Central railway tracks, between 39th and 51st Sts.; and a paper from the late Guy Miltimore considers the section between 51st and 63d Sts. Ills. Short general discussion. 10000 w. Jour W Soc of Engrs—Feb., 1905. No. 68094 D.

Sewer Ventilation at Winnipeg, Man. A report of particular interest, made by Mr. Allen Hazen, in which he recommends that the sewers be ventilated through the house soil pipes, as investigations have shown that disease cannot be carried by the air of sewers. 1800 w. Eng News—March 9, 1905. No. 68272.

The Principles for the Determination of a Municipal Sewerage System (Die Grundlagen zur Berechnung von Städteentwasserungsanlagen). H. Heyd. A discussion of the fundamental principles for determining the amount of storm water and sewage to be carried off from a given locality. 3000 w. Gesundheits-Ingenieur—Jan. 20, 1905. No. 68703 D.

Subways.

Chicago's Freight Subways. An illustrated account of these subways showing the great advantage of the system. 1500 w. Sci Am—March 11, 1905. No. 68249.

The Construction of Section I, New York Rapid Transit R. R. Illustrates and describes the construction of the section between Chambers and Ann streets, including the City Hall loop and station, and the Brooklyn Bridge station, New York. 2000 w. Eng Rec—March 11, 1905. No. 68265.

WATER SUPPLY.

Cambridge, Mass.

Cambridge Water-Works. An illustrated article giving information of the plant and repairs of forty-inch steel main. 1600 w. Fire & Water—March 11, 1905. No. 68258.

Dam.

See Civil Engineering, Construction.

Electrolysis.

See Street and Electric Railways.

Filtration.

The Antietam Filters of the Reading Water Works. Illustrated detailed description of the second slow sand filter plant in this city. 1800 w. Eng Rec—March 25, 1905. No. 68627.

Fire Service.

Proposed High-Pressure Fire System for the Borough of Manhattan, New York. An abstract of the report of I. M. de Varona, proposing a system to protect the business area of New York. 4500 w. Eng News—March 23, 1905. No. 68587.

The Revised Plans for a Fire-Protection Water System for New York. Outlines the plans for protecting the so-called dry-goods district of the city as proposed by I. M. De Varona. 2000 w. Eng Rec—March 25, 1905. No. 68629.

We supply copies of these articles. See page 319.

Water Supply for Fire Service. Treats of the hydraulic phase of fire protection, as distinguished from the work of the chemical engine. 4800 w. Fire & Water —March 25, 1905. No. 68610.

Gravity Tunnel.

Gravity Tunnel for the New Water-Works of Cincinnati. J. A. Hiller. An illustrated detailed description of the construction. 3500 w. Eng Rec—March 4, 1905. No. 68180.

Irrigation.

A Great Irrigation Project in the Punjab. An illustrated account of a new project, estimated to cost about £5,200,000 for the construction of a great irrigation system. Map. 2700 w. Engr, Lond—Feb. 17, 1905. No. 68058 A.

Pumping System.

Coolgardie, Australia, Pumping System. An illustrated article giving an abbreviated history of the greatest pumping scheme ever carried out. 3000 w. Min & Sci Pr—Feb. 25, 1905. No. 68177.

Rainfall.

Maximum Rates of Rainfall at Boston. Continued discussion of paper by Charles W. Sherman. 4000 w. Pro Am Soc of Civ Engrs—March, 1905. No. 68577 E.

Rand.

The Rand Water Board. An account of the movement to supply the Witwatersrand area with water for the growing demands of the inhabitants, industries and trades. 5000 w. Engr, Lond—March 17, 1905. No. 68663 A.

Regulating Valve.

An Automatic Regulating Valve for Reservoirs or Stand-Pipes Supplied from a Higher Elevation. J. W. Ledoux. Illustrated description of a device that has been tested and works with certainty. 900 w. Eng News—March 9, 1905. No. 68277.

Reservoirs.

The New Reservoir Dams at Solingen (Les Nouveaux Barrages-Réservoirs de Solingen). M. Jacquinot. A comparison of some recently constructed reservoir dams in Germany with similar structures in France. 2000 w. Génie Civil—Feb. 25, 1905. No. 68414 D.

Stave Pipes.

Stave Pipes for Conveying Water. Illustrations and description of the line of wood stave pipe of the Washington and Oregon Power Co., in Northeastern Oregon, in connection with their hydro-electric power plant. 1800 w. Min & Sci Pr—March 18, 1905. No. 68633.

Wood Stave Conduit. Kenneth Allen. Illustrates and describes the construction of the new conduit for Atlantic City water supply. 2200 w. Munic Jour & Engr—March, 1905. No. 68260 C.

Thawing.

Electrical Thawing of Water Pipes. From a report by George S. Haley for the Nat. Elec. Lgt. Assn. Describes the requisites and methods of procedure. 2800 w. Can Engr—March, 1905. No. 68243.

Wales.

Swansea Water Works. Illustrated description of works for increasing the water supply, consisting of a storage reservoir, tunnel, pipe-line, and service reservoir, explaining the interesting features. 2400 w. Engng—March 3, 1905. No. 68307 A.

Water Meters.

Accuracy Tests of Water Meters at Des Moines, Ia. Charles B. Burdick. Abstract of a paper read at meeting of the Illinois Soc. of Engrs. Reports the testing of 1,064 meters of various makes and sizes. 1500 w. Eng News—March 9, 1905. No. 68283.

Water Pipe.

Cost of Laying a 12-in. Water-Pipe Across a River. An account of how a 500-ft. line of 12-in. water pipe was laid and the cost. 700 w. Eng News—March 2, 1905. No. 68116.

West Africa.

Water Supply of West African Towns. Henry Reeve. Describes the protected tanks for holding rain-water, the construction of wells, and other means of supply suited to the location and conditions. 4500 w. Jour Roy San Inst—Jan., 1905. No. 68069 E.

WATERWAYS AND HARBORS.

Backwater.

The Maximum Absolute Height of Backwater behind a Weir (Das Absolute Maximum des Hydraulischen Staues). Dr. B. Tolman. Deriving formulas and a diagram for computing the height to which water is backed up at any given distance behind a dam or weir. 1800 w. Zeitschr d Oesterr Ing u Arch Vér—March 3, 1905. No. 68461 D.

California.

Report of the Commission of Engineers on the Rectification of the Sacramento and San Joaquin Rivers. Describes work, to cost nearly 25 million dollars, for protecting some 1,700 sq. miles from floods. Map. 7500 w. Eng News—March 9, 1905. No. 68276.

Canada.

Harbor and River Works in Canada. Extracts from the report of A. Gobeil giving a general review of the works now

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under construction by the Government. 4400 w. Can Engr—March, 1905. No. 68242.

Canal Lift.

Inclined-Plane Canal Lifts (Ueber Schiffs-Förderung auf Schiefen Ebenen mit Längsneigung). Fr. Jebens. A discussion of canal lifts in which the boats are floated in tanks, the latter being drawn up on tracks on inclined planes. 1800 w. Glasers Annalen—March 15, 1905. No. 68457 D.

Cranes.

Shipyard Cranes and their Functions in Marine Construction. Jos. S. Shultz. A fully illustrated review of the principal types, showing their applications and performance as labor saving machines. 3500 w. Engineering Magazine—April, 1905. No. 68723 B.

Current Propulsion.

The Propulsion of Boats by the Current (Propulsion des Bateaux par le Courant). G. Laurent. Proposing a method of propelling boats in canals and other artificial waterways by the maintenance of a continuous current in the stream. 1800 w. Rev Technique—Feb. 25, 1905. No. 68427 D.

Dredging.

Sand-Pump Dredging on the Mersey. The present article is mainly an illustrated description of the latest sand-pump dredger, "Coronation," and its working. 4000 w. Engng—March 10, 1905. Serial. 1st part. No. 68538 A.

Dry Dock.

The Construction of the Charleston Dry Dock. An illustrated detailed description of difficult foundation work. 2400 w. Eng Rec—March 4, 1905. No. 68183.

Mississippi.

The Improvement of the Mississippi River Between St. Louis and Cairo. William P. Wooten. A paper published by the Engng. School, U. S. A., Washington Barracks, D. C. A summary of the work in progress by the U. S. Government, with interesting explanation of the natural causes that produce the conditions found in the beds of such rivers. 5200 w. Eng News—March 9, 1905. No. 68274.

Movable Dam.

The Beaver Movable Dam. W. H. Chadbourn, Jr. Illustrates and describes a movable dam in the Ohio River, about 31 miles from Pittsburg, which was opened in August, 1904. 3000 w. Eng Rec—March 11, 1905. No. 68269.

Panama.

Report of the Committee on Engineering of the Isthmian Canal Commission. Report of William H. Burr and William Barclay Parsons outlining the work of the Committee between Jan. 24 and Feb. 14. 5000 w. Eng News—March 2, 1905. No. 68120.

Report on, and Progress Views of, the Panama Canal. Gives interesting views of excavation on the Panama Canal, with some general information, and the report of the engineering committee of the Isthmian Canal Commission. 7000 w. Ry & Engng Rev—March 18, 1905. No. 68505.

Some Engineering Features of the Panama Canal. F. E. Turneaure. Gives a general description of the work, discussing the Bohio dam, the Culebra Cut, and other features. 3800 w. Wis Engr—March, 1905. No. 68603 D.

The Equipment of Engineers Going to Panama. Henry A. Harris. Valuable information from competent authority in regard to clothing needed, accommodations, cost of living, &c., and the general conditions to be found on the isthmus. 2300 w. Eng News—March 2, 1905. No. 68115.

The Panama Canal. The present article reviews the recent history of the project, explaining present conditions. 3500 w. Engr, Lond—March 3, 1905. Serial. 1st part. No. 68312 A.

Rhine.

The Technology of Waterway-Improvement, with Especial Reference to the Rhine (Technik und Wasserstrassenabgaben mit besondrer Beziehung auf den Rhein). Dr. J. Landgraf. A review of the improvements which have been made on various stretches of Rhine, with data as to costs. 3500 w. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68410 D.

Stream Gauging.

See Civil Engineering, Measurement.

ELECTRICAL ENGINEERING

COMMUNICATION.

Exchange.

The Conversion of a Telephone Exchange from the Magneto to the Central Battery System. B. S. Cohen. Describes the methods adopted in carrying out the conversion, with as little inconvenience as possible to the telephone public. 1500 w. Elec Rev, Lond—Feb. 17, 1905. Serial. 1st part. No. 68064 A.

We supply copies of these articles. See page 319.

Rectifier.

An Electrolytic Rectifier for Telephone Stations (Elektrolytischer Gleichrichter für Fernsprechanlagen). R. Stosberg. Illustrating an arrangement of electrolytic rectifier for converting three-phase into continuous current, for telephone service. 800 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68473 B.

Ship Telephones.

Telephones on the Great Northern Steamship Minnesota. A. F. Boardman. Illustrated detailed description of what is said to be the largest installation of a telephone system on shipboard. 1400 w. Marine Engng—March, 1905. No. 68107 C.

Space Telegraphy.

Interference in Wireless Telegraphy. John Stone Stone. Read before the Canadian Soc. of Civ. Engrs. Discusses interference due to static charges and interference due to electromagnetic waves. 4800 w. Elec Rev, N. Y.—March 25, 1905. No. 68607.

The Schloemilch Electrolytic Detector. A. Frederick Collins. Describes this instrument for use as a transmitter, with a telephone receiver for space telegraphy. 900 w. Elec Wld & Engr—March 11, 1905. No. 68284.

Wireless Telegraph Licences. Full text of the "Commercial" licence prepared by the British Postmaster-General in accordance with the terms of the Wireless Telegraph Act, 1904. Also editorial. 5700 w. Elect'n, Lond—March 17, 1905. No. 68652 A.

Telegraphy.

Setting Type by Telegraph. Donald Murray. Briefly considers the conditions to be fulfilled, and the work that has been done, especially describing the Murray automatic system. Ills. 13500 w. Inst of Elec Engrs—Feb. 23, 1905. No. 68379 D.

Telephone Lines.

Telephone Line Engineering. C. J. H. Woodbury. Explains methods of standard aërial and underground-line construction and methods of overcoming difficulties through mountains, over rivers, gorges and savannahs. 9500 w. Jour Fr Inst—March, 1905. No. 68343 D.

DISTRIBUTION.

Alternating Current.

The Variation of Power with Resistance in an Alternating-Current Circuit. E. P. Hollis. Brief account of an investigation showing that the maximum power is obtained in an alternating-current circuit when the resistance is equal to the reactance. 400 w. Elec Engr, Lond—March 10, 1905. No. 68524 A.

Cables.

The Selection of Electric Cables. L. B. Atkinson and C. J. Beaver. Read before the Manchester Sec. of the Inst. of Elec. Engrs. The present part deals with rubber insulated cables, the tests of materials, &c. Gives hints for the selection of cables. 3500 w. Elect'n, Lond—Feb. 17, 1904. Serial. 1st part. No. 68066 A.

Earthing.

"Earthing." W. W. Lackie. Abstract of a paper read at Glasgow, before the Inst. of Elec. Engrs. Criticises the regulations issued by the Inst. of Elec. Engrs. and emphasizes the necessity of insulating the sheathing throughout its length, earthing it at one point only, and introducing a proper sized resistance on the earth circuit. 3500 w. Elec Rev, Lond—Feb. 17, 1905. No. 68063 A.

Faults.

The Localization of Faults on Cables. Explains a method of localizing faults in light and power cables by use of a dynamo and motor; measuring the drop in pressure across the fault. 1200 w. Elec Rev, Lond—March 3, 1905. No. 68303 A.

Regulator.

A New Electromagnetic Contact Arrangement for Automatic Switches (Ueber eine Neue Elektromagnetische Kontaktvorrichtung für Selbsttätige Schaltwerke). Paul Thieme. Describing an improved form of automatic switch for maintaining a constant voltage between given points. 3000 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68472 B.

The Use of an Auxiliary Dynamo as a Battery Regulator (Verwendung von Zusatzmaschinen als Zellenschalter). B. Jacobi. Describing a convenient regulating system for a small electric station, using a storage battery. 2000 w. Elektrotech Zeitschr—March 9, 1905. No. 68477 B.

ELECTRO-CHEMISTRY.

Applied Chemistry.

Recent Examples of Applied Chemistry. James M. Camp. Address of the retiring president of the Engrs.' Soc. of W. Penn. Deals largely with applications made possible by electrochemistry. 3500 w. Pro Engrs' Soc of W Penn—Feb., 1905. No. 68089 D.

Calculations.

Metallurgical Calculations. J. W. Richards. The first article of a serial on this subject, giving the scope of the treatise and introductory remarks, and discussing the chemical equation, weights and volumes of gases, correction of gas volumes for temperature and pressure, with problems. 4000 w. Elec-Chem &

We supply copies of these articles. See page 319.

Met Ind—March, 1905. Serial. 1st part. No. 68151 C.

Card Index.

A System of Classification for an Electrochemical Bibliography. Adolph L. Volge. An explanation of a system on the decimal system for arranging a card index. 2400 w. Elec-Chem & Met Ind—March, 1905. No. 58152 C.

De-Tinning.

Methods of Removing the Tin from Tin-Plate Wastes (Fortschritte auf dem Gebiete der Entzinnung von Weissblechabfällen). Dr. H. Mennicke. A review of the development of electrolytic process for recovering the metallic tin from tinplate scrap. Serial. Part I. 2000 w. Elektrochem Zeitschr—Feb., 1905. No. 68487 G.

Dissociation.

The Theory of Electrolytic Dissociation (La Théorie de la Dissociation Electrolytique). Max Roloff. A review of recent studies in electrolytic dissociation, based upon the theory of ions. Serial. Part I. 3000 w. L'Electrochimie—Jan., 1905. No. 68489 D.

Electro-Metallurgy.

Electro-Production of Iron and Steel. Details from the report of the Canadian Commission, appointed to investigate the different electro-thermic processes for the smelting of iron ores and the making of steel. 2500 w. Engr, Lond—March 3, 1905. No. 68314 A.

Recent Developments in Electric Smelting in Connection with Iron and Steel. F. W. Harbord. Read before the Faraday Society. Mainly a résumé of the report of the Canadian Commission. 3800 w. Ir & Coal Trds Rev—March 10, 1905. No. 68549 A.

The Kjellin Process for the Electric Refining of Steel (Das Kjellinsche Verfahren zur Elektrischen Erzeugung von Stahl). V. Engelhardt. A description of the plant at Gysinge in Sweden, and data concerning the cost of the electric smelting of steel. Three articles. 5000 w. Stahl u Eisen—Feb. 1, 15, March 1, 1905. No. 68434 each D.

The Thermo-Chemistry of Iron Ore Reduction and Steel Making in the Electrical Furnace. Horace Allen. Discusses the limits necessitated by the chemical reactions. 2500 w. Cassier's Mag—March, 1905. No. 68125 B.

Solid Electrolytes.

Electrochemical Reactions in Solid Electrolytes. Prof. F. Haber and H. Tolloczko. Report of investigations, especially of the electrolysis of solid barium chloride at about 400° below its melting point. 2000 w. Elec-Chem & Met Ind—March, 1905. No. 68150 C.

Tantalum.

The Preparation and Properties of Tantalum (Das Tantal, seine Darstellung und seine Eigenschaften). Dr. Werner von Bolton. Describing fully the electrolytic method of producing pure tantalum for use in the tantalum incandescent lamp. 3000 w. Zeitschr f Elektrochemie—Jan. 20, 1905. No. 68485 D.

ELECTRO-PHYSICS.

Alloy.

Experiments upon the Heusler Ferromagnetic Alloy of Manganese, Aluminium, and Copper (Versuche mit Heuslerschen Ferromagnetischen Mangan-Aluminium-Kupfer Legierungen). E. Gumlich. A report of the tests made by the Reichsanstalt upon the magnetic properties of an alloy composed of non-magnetic metals. 5000 w. Elektrotech Zeitschr—March 2, 1905. No. 68475 B.

Dampers.

The Effect of Dampers on Harmonics (Sur les Etouffeurs d'Harmoniques). Maurice Leblanc. Discussing a method of inserting damping coils in alternators so as to suppress the harmonic irregularities in the alternations. 6000 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68491 F.

Dielectrics.

Report on Temperature Experiments Carried Out at the National Physical Laboratory. E. H. Rayner. Deals with investigations undertaken on behalf of the Engineering Standards Committee. The first part was on the effect of heat on the properties of insulating materials usually employed in electrical machinery; the second deals with the internal temperature of field coils of continuous-current machinery. 10400 w. Ill. Inst of Elec Engrs—March 9, 1905. No. 68639 D.

Eddy Currents.

Eddy-Current Losses in Massive Pole Shoes (Wirbelstromverluste in Massiven Polschuhen). Reinhold Rüdenberg. Deriving formulas for the computation of the losses due to eddy currents, based upon the oscillation theory. 3500 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68471 B.

Foucault Currents in the Armature Cores of Continuous-Current Dynamos (Sur les Courants de Foucault dans le Fer Induit des Machines à Courant Continu). R. V. Picou. A mathematical examination, showing that the losses from eddy currents are greater than has hitherto been admitted. 3000 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68490 F.

Electric Discharges.

The Ionic Theory of the Arc and Spark.

We supply copies of these articles. See page 319.

Prof. Henry Crew. Considers the two modes of ionization involved, and how nearly the electron theory explains the action. 8200 w. Jour W Soc of Engrs—Feb., 1905. No. 68093 D.

The Law of Electrical Discharges Through Air. Gives results of some interesting tests on the length of discharge path in air at high voltages as described by H. Grob in a recent article in the *Elektrotechnische Zeitschrift*. 1400 w. Elec Engr, Lond—Feb. 24, 1905. No. 68214 A.

Potential Differences.

Electric Potential and Sparking Distance in Air. Briefly examines recent work on high potential differences, with particular reference to the sparking distance in air. 2000 w. Engng—March 17, 1905. No. 68661 A.

Radio-Activity.

Radium and Radio-Activity in General. Robert H. Bradbury. The atomic theory; radium rays; the radio-active process in comparison with ordinary chemical changes, &c. 4000 w. Jour Fr Inst—March, 1905. No. 68347 D.

Solenoids.

Predetermination of Solenoid Characteristics. Paul C. Percy. Describes method of getting approximate dimensions and excitation for designing a stopped solenoid, giving tables for use, and illustrating their application by examples. 1200 w. Am Elect'n—March, 1905. No. 68141.

Transformers.

A Note on Transformers (Sur les Transformateurs). E. Brylinski. A mathematical discussion of the phenomena of resonance as exhibited in the operation of transformers. 3500 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68492 F.

GENERATING STATIONS.

Alternators.

Expressions for the Power Delivered by Two Alternators in Parallel (Expression des Puissances Fourmés par Deux Alternateurs en Parallele). C. F. Guilbert. Developing graphical methods for determining the relative and joint performances of the two machines. Two articles. 4000 w. Rev Technique—Feb. 10, 25, 1905. No. 68424 each D.

Parallel Operation of Dynamos Having Different Characteristics. Lamar Lyndon. Considers a case of paralleling several generators having different characteristics, explaining facts necessary to a clear understanding. Diagrams. 2000 w. Am Elect'n—March, 1905. No. 68143.

Parallel Running of Alternators Driven by Large Gas Engines. E. Kilburn Scott. Considers there is no difficulty whatever in running three-phase generators in parallel when driven by large gas engines, and calls attention to some points to be remembered. 1000 w. Elec Rev, Lond—March 10, 1905. No. 68527 A.

The Erection of 5,000-KW. Engine-Driven Alternators. R. L. Wilson. Illustrates and describes the installation of the generators which furnish power for the operation of the trains in the New York Subway. 3800 w. Eng News—March 23, 1905. No. 68584.

Bridlington.

Bridlington Electricity Works. An illustrated article giving the history of this undertaking in England, with description of the works and their equipment. 3300 w. Elec Engr, Lond—March 3, 1905. No. 68301 A.

Dynamos.

Acyclic (Homopolar) Dynamos. Discussions at New York and Boston of paper by J. E. Noeggerath. 4,000 w. Am Inst of Elec Engrs—March, 1905. No. 68560.

Electrical Machinery.

Diseases of Electrical Machinery. F. B. Crocker and S. S. Wheeler. A statement of troubles with their symptoms and remedies, prepared to facilitate their detection and elimination. Ills. 4800 w. Am Elect'n—March, 1905. No. 68144.

Electrical Plant.

The Frodingham Iron and Steel Company's New Electrical Plant. An illustrated description of an interesting power and lighting plant. 2000 w. Ir & Coal Trds Rev—March 3, 1905. No. 68317 A.

Hydro-Electric.

An Important Italian Hydro-electric Installation. Enrico Bignami. Brief illustrated description of a new water-power station planned by Italian engineers and equipped entirely with Italian machinery, at Zogno, Italy. 800 w. Elec Rev, N Y—March 11, 1905. No. 68288.

Interesting Power Plant at Olympia, Washington. Illustrated description of a new and thoroughly modern water-power plant. 1500 w. St Ry Jour—March 11, 1905. No. 68261 C.

Large Norwegian Power Installation. Brief description of the Kykkelsrud power installation, comprising a water-power of 45,000 effective horse-power. 1000 w. Engng—March 10, 1905. No. 68540 A.

The Cellina Hydro-Electric Plant (L'Impianto Idroeléttrico del Cellina). A full description of the plant at Cellina near Pordenone, in Northern Italy, deriving 2600 horse-power from the Cellina. Two articles, 4000 w. L'Elettricita—Feb. 10, 24, 1905. No. 68715 each B.

We supply copies of these articles. See page 319.

The Gromo Hydro-Electric Plant. (Nuovo Impianto Idro-Elettrico di Gromo). Illustrating and describing a plant deriving 2000 horse-power from the Serio, at Gromo, in Northern Italy. 3000 w. Il Monitore Tecnico—Jan. 30, 1905. No. 68710 D.

The Hydraulic Power of Lakes Joux and Orbe (Les Forces Motrices des Lacs de Joux et de l'Orbe). C. H. Perrin. A description of the power stations at La Dernier and Montcherand deriving 6000 to 8000 horse-power each from the mountain streams above the Lake of Geneva. Two articles, 6000 w., 1 plate. Génie Civil —Feb. 25, March 4, 1905. No. 68413 each D.

The Japanese Hydro-Electric Power Plant at Kyoto and Lake Biwa Canal Development. Frank C. Perkins. Illustrations and drawings showing the present hydro-electric power development of the Lake Biwa canal, describing this and the proposed new waterway of much larger capacity. 2000 w. Sci Am Sup—March 18, 1905. No. 68330.

See also Mechanical Engineering, Hydraulics.

Isolated Plant.

Power and Lighting Equipment of a Brooklyn Museum. E. T. Walsh. Illustrates and describes the plant of the Brooklyn Inst. of Arts and Sciences. 2500 w. Am Elect'n—March, 1905. No. 68139.

Some Notes on the Running of a Private Lighting and Power Plant. P. T. Blisset. Read before the Dublin Loc. Sec. of the Inst. of Elec. Engrs. Descriptive notes of a large private three-wire light and power plant, showing how electrical driving has gradually superseded steam driving and gas lighting. 2500 w. Elec Eng, Lond—Feb. 24, 1905. Serial. 1st part. No. 68213 A.

Power House.

Construction of the Port Morris Power House for the New York Central R. R. Brief description of methods of constructing the foundations for a 30,000 k.w. power house. Ills. 1800 w. Eng Rec—March 4, 1905. No. 68186.

Power House of the Indianapolis & Cincinnati Traction Company. Illustrated detailed description of the power station at Rushville, Ind., and its equipment. 3500 w. St Ry Jour—March 18, 1905. No. 68392 C.

Station Troubles.

An Unusual Power Station Trouble. L. H. Pike. Gives an account with diagrams, of an actual occurrence, and the method of remedying it. 2500 w. Power—March, 1905. No. 68171 C.

Switchboards.

An Ideal Switchboard Base. Leonard J. Pumphrey. Gives results of experiments made on marble, slate and opaline switchboards, showing the superiority of the last named material. 1200 w. Elec Rev, Lond—Feb. 24, 1905. No. 68217 A.

Switchgear.

Switchgear for the Fisher Street Substation of the Metropolitan Electric Supply Company, Limited, London. Illustrates and describes the unique features of this gear, such as the remote control from one platform, the protected extra high tension connections, the depressor method of starting, etc. 3000 w. Elec Engr, Lond —Feb. 24, 1905. No. 68211 A.

Switzerland.

The Municipal Electric Station at Winterthur (Das Stadtische Elektrizitätswerk in Winterthur). S. Herzog. Illustrating and describing especially the transformer station and rotaryconverter plant. 1800 w. Zeitschr f Elektrotechnik —March 12, 1905. No. 68484 D.

Tariffs.

Methods of Charging for Electric Current (Ueber einige Stromtariffragen). Dr. Gotthold Stern. A discussion of the various methods of determining the price to be charged the customer for electric current supply. 3000 w. Zeitschr f Elektrotechnik—Feb. 19, 1905. No. 68479 D.

The Charges for Municipal Electric Lighting Plants (Städische Lichtwerke und deren Besteuerung). Paul Hecht. Giving data of operating costs, and discussing the best method of distributing charges. 1800 w. Zeitschr f Elektrotechnik—Feb. 26, 1905. No. 68481 D.

Taunton, Mass.

The Largest Municipal Plant in New England. Alan D. Adams. Illustrated description of the new plant at Taunton, Mass. 2500 w. Elec Rev, N Y—March 4, 1905. No. 68128.

Transformers.

Oil-Insulated Versus Air-Blast Transformers. M. A. Sammett. Gives practical results aiming to show the superiority of the oil-insulated type. 2500 w. Elec Rev, N Y—March 18, 1905. No. 68394.

LIGHTING.

Mercury Vapor.

Physiological Effects of the Mercury-Vapor Lamp (Physiologische Betractungen über die Wirkungen von Quecksilberdampflampen). Dr. E. Schiff. Discussing especially the action of the emitted violet rays upon the human skin. 1200 w. Zeitschr f Elektrotechnik—March 5, 1905. No. 68483 D.

Progress with the Mercury-Vapor Lamp (Fortschritte bei Quecksilberdampf-

lampen). S. Strauss. Describing recent developments with the Cooper-Hewitt lamp in Europe and America. 3000 w. Zeitschr f Elektrotechnik—March 5, 1905. No. 68482 D.

Nernst.

The Nernst Lamp (Die Nernst-lampe). Dr. Ernst Salomon. An address before the Electrotechnical Society of Vienna, reviewing the development of the Nernst lamp in Germany. 3000 w. Zeitschr f Elektrotechnik—Feb. 26, 1905. No. 68480 D.

Osmium.

The Osmium Incandescent Electric Lamp (Die Elektrische Osmium Glühlample). Fritz Blau. A paper before the Berlin Electrotechnical Society, giving data as to the life and illuminating power of the Welsbach osmium lamp. 4000 w. Elektrotech Zeitschr—Feb. 23, 1905. No. 68474 B.

Portable Plant.

English Fire Engine Portable Electric Light Operated with Liquid Fuel. Frank C. Perkins. Illustrations and drawings showing the details of construction and method of operating a new English portable electric light plant for fire department service. 500 w. Elec, N Y—March 1, 1905. No. 68085.

School Lighting.

The Lighting of School Rooms (Ueber die Beleuchitung von Schulräumen). Prof. Ludw. Stelz. Data and results of tests of the distribution of light from incandescent electric lamps in the rooms of the Göthe gymnasium in Frankfort. 2500 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68467 B.

Tantalum Lamps.

Some Tests of Tantalum Lamps. A. E. Kennelly and S. E. Whiting. An account of some interesting tests made in the laboratory of Harvard University. 1200 w. Elec Wld & Engr—March 25, 1905. No. 68636.

Train Lighting.

See Railway Engineering, Motive Power and Equipment.

MEASUREMENT.

Amperemeter.

An Amperemeter for High Potential Currents. H. Clyde Strook. Describes an instrument for measuring currents flowing in the secondary circuits of induction coils. It is especially adapted for use in X-ray work. 2000 w. Jour Fr Inst—March, 1905. No. 68344 D.

The Application of the Carpentier Thermic Amperemeter to the Determination of Power Factors (Application de l'Ampèremètre Thermique J. Carpentier à la Mesure des Puissances et des Decalages). L. Joly. Showing how the Carpentier amperemeter replaces the voltmeter, amperemeter and wattmeter. 3500 w. Bull Soc Int d Electriciens—Feb., 1905. No. 68494 F.

Harmonic Analysis.

Harmonic Analyzer. George H. Rowe. Describes a particular form of analyzer designed to be accurate and inexpensive and of sufficient range for all practical purposes. Also editorial. 2500 w. Elec Wld & Engr—March 25, 1905. No. 68635.

Instruments.

Instruments of Precision and a New Type of Portable Instruments. J. Brown. Describing the Westinghouse integrating wattmeter, portable ammeter, and power-factor meter, with data concerning calibrating and testing. 3300 w. Wis Engr—March, 1905. No. 68602 D.

Lightning Recorder.

A Simple, Effective, and Inexpensive Lightning Recorder. Henry F. Alciatore. Illustrated description of a lightning recorder designed to obtain automatic records of the hundreds of electric discharges, visible and invisible, that usually precede and accompany thunder-storms. 1800 w. Sci Am Sup—March 18, 1905. No. 68333.

Meters.

Polyphase Meters. Deals only with watt-hour-meters and the theory underlying them. 1200 w. Elec Rev, Lond—March 10, 1905. No. 68526 A.

Oscillograph.

Notes on Some Effects on Three-Phase Working. W. M. Thornton. Read before the Newcastle Local Sec. of the Inst. of Elec. Engrs. Gives results of investigations with the oscillograph undertaken for the purpose of deciding questions of importance in the regular working of the plant. 3000 w. Elec Engr, London—March 10, 17, 1905. Serial, 2 parts. No. 68647 each A.

Oscillograph Investigations by the Central Laboratory of Electricity (Recherches Oscillographes Effectuées par la Laboratoire Central d'Electricité). Ch. David. An account of experiments conducted on the high tension lines of the company "Energie Electrique du Littoral Mediterranean." 10,000 w. Bull Soc Int d Electriciens—Jan., 1905. No. 68493 F.

Potentiometer.

The Potentiometer. W. M. Nelson. Read before the Queensland Elec. Assn. Briefly describes the instrument and discusses its possibilities for general testing

and measurement of electromotive force. 3500 w. Aust Min Stand—Feb. 9, 1905. No. 68553 B.

Rating.

Temperature Curves and the Rating of Electrical Machinery. Rud. Goldschmidt. Discusses short-time rating; the temperature curve; heating and cooling; crane rating, etc., giving methods and examples. 7500 w. Inst of Elec Engrs—March 9, 1905. No. 68646 D.

Testing.

Instrument Equipment of a Testing Department. F. Conrad. Read before the Ohio Elec. Lgt. Assn. Considers portable testing instruments, auxiliary devices, and standard instruments. 3300 w. Cent Sta —March, 1905. No. 68285.

Voltameters.

Mercury Voltameters (Ueber Quecksilbervoltameter). H. Danneel. Describing various forms of mercury voltameter, showing how they may be employed as electric meters. 2000 w. Zeitschr f Elektrochemie—March 10, 1905. No. 68486 D.

MOTORS.

Induction Motors.

A Practical Vector-Diagram for Induction Motors. H. C. Specht. An explanation of a vector diagram method for analyzing the behavior of induction motors which is applicable to single-phase as well as polyphase induction motors of all sizes. 4000 w. Elec Wld & Engr—Feb. 25, 1905. No. 68081.

The Computation of the Stray Co-efficient of Induction Motors (Berechnung des Streuungskoffizienten bei Drehstrommotoren). Karl Pichelmayer. Deriving formulas for practical use, with tabulated results of its application to a number of machines. 2500 w. Zeitschr f Elektrotechnik—Feb. 12, 1905. No. 68478 D.

Machine Driving.

See Mechanical Engineering, Power and Transmission.

Railway Motors.

The Alternating-Current Series Motor. F. D. Newbury. An illustrated article explaining the advantages of the neutralizing field winding. 900 w. Elec Club Jour—March, 1905. No. 68507.

TRANSMISSION.

Efficiency.

Electrical Transmission. G. W. Worrall. Read before the Liverpool Univ. Engng. Soc. Discusses efficiency of transmission, the form of current best adapted, high tension transmission, inductance and capacity, with brief description of the system of M. Thury, a Swiss engineer. 2800 w. Elec. Engr, Lond—March 17, 1905. No. 68648 A.

High Tension.

The First European Transmission at 40,000 Volts from Gromo to Nembro (La Prima Trasmissione Europea a 40,000 Volt tra Gromo e Nembro). Describing the new line over which the 2000 horsepower of the Gromo station is delivered to Nembro, a distance of 32 kilometres. Two articles, 3500 w. L'Elettricita—Jan. 20, 27, 1905. No. 68714 each B.

Insulators.

High-Tension Insulators. E. H. Craffer. An illustrated article considering insulators for high-pressure wires, the requirements, etc. 2500 w. Engng—March 17, 1905. Serial. 1st part. No. 68657 A.

Oil for Insulating Purposes. Abstracted from a pamphlet published by the Westinghouse Elec. & Mfg. Co., of Pittsburg, written by C. E. Skinner. On methods of testing, and the quality of oil for transformer and oil-switch work. 2500 w. Elec Rev, N Y—March 18, 1905. No. 68395.

INDUSTRIAL ECONOMY

Cost Keeping.

The Cost System of an Engineering Works. H. Deighton. Detailed description of a successful working system, including cost keeping, stock tracing, stores control, and general accounting. 4500 w. Engineering Magazine—April, 1905. No. 68722 B.

Electric Transmission.

Economics of Transmission Problems. F. A. C. Perrine. Abstract of a lecture delivered before the Brooklyn, N. Y., Poly. Inst. Considers electric transmission a problem of economics rather than of engineering. 1500 w. Elec Rev, N. Y. —March 4, 1905. No. 68130.

Some Economic Aspects of Electric Power Distribution. Dr. Louis Bell. A discussion of the important influence of electric power distribution in redistributing industry and population. 3500 w. Engineering Magazine—April, 1905. No. 68719 B.

Office Work.

New Methods of Office Work. LeRoy Scott. Describes the many kinds of work

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now performed rapidly by ingenious machines, which formerly required much time and many hands. 3000 w. World's Work—March, 1905. No. 68164 C.

Order Craziness.

An editorial pointing out the poor business policy of permitting salesmen, through eagerness for orders, to urge the purchase of mechanical equipment actually unsuited to the needs of customers. 600 w. Air Power—April, 1905. No. 68718.

Patent Laws.

Patent Law with Reference to Engineering. C. A. Brown. Considers patentable inventions; the rights of the engineer and his client or employer with reference to inventions made by an engineer during his employment; and the function of the patent expert. 7300 w. Wis Engr —March. 1905. No. 68604 D.

Peat.

The Industrial Utilization of Peat for the Manufacture of Fibrous Packing (Die Technische Verwertung von Torfmooren zur Torfstreufabrikation). Bruno Simmersbach. Illustrating and describing a plant for the conversion of peat into a fibrous material for covering steam pipes, packing fragile articles, etc. 3000 w. Glasers Annalen—March 1, 1905. No. 68454 D.

Sanitary Betterment.

Sanitary Betterment in Large Industrial Plants. Severance Burrage. Considers the factors that have brought about the movement for improving these conditions, and gives illustrated descriptions of arrangements at various works. General discussion. 6500 w. Jour W Soc of Engrs—Feb., 1905. No. 68092 D.

Specialization.

Specialization in Manufacture. Abstract of a paper by Alexander E. Outerbridge, Jr., from *Annals of the Am. Acad. of Pol. & Soc. Sci.* Gives illustrations showing the advantages of specialization, the decrease of cost and increase of production. 1500 w. Am Mach—Vol. 28, No. 9. No. 68102.

Steel Corporation.

The United States Steel Corporation. Abstract of the third annual report. 3500 w. Ir Age—March 23, 1905. No. 68556.

Technology.

A Ministry of Technical Work (Das Ministerium der Technisch Arbeit). Max v. Kraft. A discussion of the importance of system in technical work, and the desirability of making it the subject of an official department. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—March 3, 1905. No. 68460 D.

Wage System.

The Question of Wages and Rewards (Preisbewegungen und Lohnfragen). R. Gundel. A review of various methods of remunerating labor, with especial reference to the various modifications of the Halsey premium system. 3500 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68470 B.

MARINE AND NAVAL ENGINEERING

Coaling.

Coaling of Ships of War at Sea and in Harbor. G. C. Mackrow. Illustrated description of a proposed system worked out at the Thames Ironworks. Describes the loading at sea and also in harbor. General discussion. 6300 w. Jour Roy U Serv Inst—Feb. 15, 1905. No. 68068 E.

Cruiser.

The French Armored Cruiser. Ernest Renan. Illustration, with brief description, and comparative table. 500 w. Engr, Lond—March 3, 1905. No. 68316 A.

The U. S. S. Chattanooga. W. W. White. General description of the vessel and its equipment, with report of standardization and official trials. 3000 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68516 H.

Current Propulsion.

See Civil Engineering, Waterways and Harbors.

Docks.

Floating - Dock Design (Ueber Schwimmdock Anlagen). Alexander Dietzius. With sections and data of a number of executed examples by various German firms, and diagrams and curves of stability. 4000 w. 1 plate. Schiffbau —Feb. 22, 1905. No. 68701 D.

Ferryboats.

New Ferryboats for San Francisco Harbor. Illustrates and describes boats capable of a maximum speed of 17 miles per hour, and of a high power of acceleration for a 15 minute service between San Francisco and Oakland. 1000 w. Marine Engng—March, 1905. No. 68106 C.

Fireboat.

Portland's New Fireboat. George H. Williams. Illustrated description of an interesting fire tug. 1600 w. Naut Gaz—March 23, 1905. No. 68606.

We supply copies of these articles. See page 319.

Gyroscopic Horizon.

Admiral Fleuriais's Gyroscopic Horizon. An illustrated description of an improved instrument likely to render important service at sea. 1100 w. Engng—March 17, 1905. No. 68662 A.

Lake Vessels.

The 10,000-Ton Lake Vessels. An illustrated article on the three series of 10,000-ton vessels under construction, which present new and widely different features from any that have been previously built. 1000 w. Ir Age—March 16, 1905. No. 68320.

Launching.

Launch of the James C. Wallace. An account of the launch, with illustrated description of the vessel and its construction. 3000 w. Marine Rev—March 16, 1905. No. 68385.

The Influence of Launching Stresses upon Vessels (Einfluss der Stampfbewegungen beim Stapellauf auf die Beanspruchung des Schiffes). Alexander Dietzius. A discussion of the action of the dynamic forces at the time of launching, and the manner in which they cause stresses upon the hull. 3000 w. Schiffbau—Jan. 11, 1905. No. 68700 D.

Marine Engines.

See Mechanical Engineering, Steam Engineering.

Motor Boats.

Engine Details of New Auto Boats Entered for Monaco (Mediterranean) Races. René M. Petard. Illustrations, with descriptions of special engines. 2000 w. Automobile—March 25, 1905. No. 68617.

French Auto Boats and Motors. Brief descriptions, with illustrations, of recent models shown at the Paris show. 2200 w. Automobile—Feb. 25, 1905. No. 68071.

Motor Boat Engines at the Sportsmen's Show. Illustrated descriptions of several noteworthy engines exhibited. 1400 w. Sci Am—March 4, 1905. No. 68122.

Napier II.—The Yarrow-Napier Racing Launch. Illustrated description of a rebuilt English boat which is to take part in the British International Cup Race, and in other events. 1600 w. Auto Jour—March 11, 1905. No. 68519 A.

Oil-Carrying.

The Oil-Carrying Fleets of the World. J. D. Henry. Illustrates, describes and compares various types of bulk oil steamers and coal oil sailers showing the extent of this industry. 6000 w. Naut Gaz—March 2, 1905. No. 68156.

Progress.

Epochs in Marine Engineering. George W. Melville. Address delivered before the A. S. M. E. on Jan. 31, 1905. Considers the various periods with reference to the special inventions or changes which have characterized them; as the paddle wheel, the screw propeller, surface condensers, cylindrical boilers, compound engine, &c. 5400 w. Marine Engng—March, 1905. No. 68108 C.

Propellers.

Contract Trials of Ships as Experiments Upon Propellers. John Lowe. Showing that the data given furnish complete experiments upon the screw propeller of great value. 1400 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68513 H.

The Screw Propeller. R. de Villamil. The present article reviews the explanations that have been offered to explain how the screw propeller derives its thrust, and in a second article aims to show there is no solid foundation of truth in them. 3500 w. Engr, Lond—March 3, 1905. Serial. 1st part. No. 68311 A.

Repairs.

Story of the Operations of the Russian Fleet at Pt. Arthur as Told by One of the Commanders. Facts obtained in an interview with Capt. N. O. von Essen, who was in command of the battleship "Sevastopol," explaining a method of making repairs by means of caissons. Ills. 3500 w. Sci Am—March 11, 1905. No. 68250.

Resistance.

I. The Relation of Depth of Water to Speed and Power of Ships. An account of the German torpedo vessel experiments. II. A General Discussion of Resistance and Power Consumption of Ships in Different Depths of Water. D. W. Taylor. Suggested by the I. article. 5000 w. Eng News—March 16, 1905. No. 68338.

Sails.

The Design and Making of Sails. Adrian Wilson. Read before the Mass. Inst. of Tech. Briefly considers the proper distribution of the areas of the drawing power, method of finding the center of effort, different conditions under which a boat may be used, the shape and proportion of sails, &c. Ills. 5400 w. Marine Engng—March, 1905. No. 68105 C.

Scouts.

Scouts. Gives comparative data of some typical cruisers intended for scouting purposes, with information concerning this type of vessel, and remarks on its value as a warship. 1500 w. Engr, Lond—March 17, 1905. No. 68665 A.

Ship Telephones.

See Electrical Engineering, Communication.

We supply copies of these articles. See page 319.

Shipyards.

Application of Electricity to Industrial Purposes. J. F. C. Snell. Abstract of a paper read before the N.-E. Coast Inst. of Engrs. & Shipbuilders. Gives results and particulars in regard to the application of electricity to shipyards. 3000 w. Elect'n, Lond—March 3, 1905. No. 68305 A.

Stability.

The Gyration of Ships (Sur la Giration des Navires). E. Bertin. A study of the forces tending to capsize a vessel, and the statical moments by which they are resisted. 2000 w. Comptes Rendus—Feb. 6, 1905. No. 68417 D.

Steamships.

Cargo and Intermediate Steamers. From a paper by Edwin W. De Russett, in the Pro. of the Inst. of Civ. Engrs., London. Considers recent developments in Great Britain in building these two types of steamships. 2400 w. R R Gaz —Vol. XXXVIII., No. 9. No. 68147.

Strength.

The Transverse Strength of Ships (Querfestigkeit von Schiffen). J. Bruhn. An elaborate, and fully illustrated discussion of the transverse stresses acting upon the hulls of vessels and the principles of structural design involved. 5 articles. 5000 w. Schiffbau—Nov. 23, Dec. 14, 1904, Jan. 11, 25, Feb. 22, 1905. No. 68699 each D.

Methods of Estimating the Strength of Ships. Dr. J. Bruhn. Discusses methods of making strength calculations. 12400 w. Trans Inst of Engrs & Shipbuilders of Scot—Feb. 21, 1905. No. 68687 D.

Trials.

Cunard Liner Caronia. Illustrated description of this Cunard liner, her engines and her speed trials. 1400 w. Marine Rev—March 2, 1905. No. 68202.

Steam Trials of H. M. S. "Carnarvon." An illustrated description of this armored cruiser and report of the satisfactory results of the steam trials. 3500 w. Engng —March 17, 1905. No. 68658 A.

The U. S. S. Pennsylvania. Lewis Hobart Kinney. Illustrated detailed description of the vessel and its equipment, with report of trial. 8500 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68512 H.

United States Armored Cruisers West Virginia and Maryland. W. Strother Smith. Illustrated description of vessels with report of official trials. 7500 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68514 H.

Vibrations.

Apparatus for Recording the Vibrations of Steamers. An illustrated description of Schlick's recording apparatus for steamship vibrations, called a pallograph. 1200 w. Engng—March 3, 1905. No. 68308 A.

Weight.

The Weight of Ships (Il Peso delle Navi). Edwin Cerio. An examination of the computation and distribution of weights in a vessel, including hull, machinery, fuel, armament, etc. 6000 w. 2 plates. Rivista Marittima—Feb., 1905. No. 68698 H.

MECHANICAL ENGINEERING

AUTOMOBILES.

Body Building.

Artistic Body Building Methods. An illustrated article describing methods of designing and finishing in a Chicago carriage-building factory. 2500 w. Automobile—Feb. 25, 1905. No. 68073.

Charging Accumulators.

A New Method of Charging Accumulators. Illustrates and describes a small portable dynamo arranged on a base plate, together with the volt and ammeter. It is driven by means of a friction wheel rotated by one of the rear wheels of the car. 900 w. Autocar—March 11, 1905. No. 68550 A.

Clement-Talbot.

The 8 H. P. and 12 H. P. Clement-Talbot Cars. An illustrated detailed description. 1700 w. Autocar—March 18, 1905. Serial. 1st part. No. 68645 A.

Clutch.

The Bradley Multiple-Disc Clutch. Illustrates and describes the improved friction-clutch invented by E. F. Bradley. 2000 w. Auto Jour—March 11, 1905. Serial. 1st part. No. 68520 A.

Differential.

The Action of the Differential Gear of Automobiles (Sur le Mode de Frictionnement du Differential des Automobiles). A. Petot. A mathematical examination of the dynamic of differential transmission gears. 1000 w. Comptes Rendus—Feb. 20, 1905. No. 68420 D.

Electric Vehicles.

Electricity at the Berlin Automobile Exposition (Die Elektricität auf der In-

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ternationalen Automobilausstellung in Berlin). C. v. Groddeck. A general description of the exhibits, with especial reference to the accumulator electric automobiles. 2500 w. Elektrotech Zeitschr—March 2, 1905. No. 68476 B.

Exhibitions.

New Cars at the Boston Show. Brief illustrated descriptions of some of the new cars shown. 3000 w. Automobile—March 18, 1905. No. 68386.

The International Automobile Exhibition in Berlin (Die Internationale Automobil-Ausstellung in Berlin). F. Pflug. A general description of the various machines exhibited. Serial. Part I. 2500 w. Glasers Annalen—March 1, 1905. No. 68455 D.

Fire Engines.

Automobiles and Fire Fighting (La Lutte contre les Incendies et l'Automobilisme). Daniel Bellet. Describing various forms of automobile fire engines, and their success in actual fire service. 3000 w. Rev Technique—Feb. 10, 1905. No. 68422 D.

"Flash" Boilers.

"Flash" Boilers for Steam-Cars. J. S. V. Bickford. An account of an extensive series of experiments on boilers for auto cars. 3300 w. Engng—March 10, 1905. No. 68539 A.

Gasoline Cars.

General Suggestions for the Operation of Gasoline Runabouts or Touring Cars. A. D. River. Aims to indicate the principles underlying all gasoline machines, and the general method of procedure in their management. 8500 w. Automobile—March 11, 1905. Serial. 1st part. No. 68253.

Union Pacific Gasoline Motor Car. Illustration, with brief description, of a car for high-speed interurban and branch service to be used experimentally for local passenger service at Portland, Ore. 700 w. Ry Age—March 10, 1905. No. 68257.

Gobron-Brillie.

The 1905 Gobron-Brillie Petrol Cars. Illustrated description. 1400 w. Auto Jour—March 4, 1905. No. 68299 A.

Industrial Vehicles.

The Thornycroft Lurries, Omnibuses, and Vans. The present article illustrates a new 24 h.p. double deck petrol omnibus for 34 passengers, and begins a description of the commercial vehicles of this company. 700 w. Auto Jour—March 18, 1905. Serial. 1st part. No. 68644 A.

The Wolseley Industrial Vehicles. Begins an illustrated description of commercial vehicles fitted with internal-combustion engines. 700 w. Auto Jour—March 18, 1905. Serial. 1st part. No. 68643 A.

Mercedes.

American Mercedes Automobiles. An illustrated article giving information concerning these cars and their manufacture. 1800 w. Automobile—March 11, 1905. No. 68255.

Omnibuses.

Motor 'Buses vs. Electric Tramways. J. Clifton Robinson. Discusses this question as affecting England. Thinks the omnibus will find its usefulness as a "feeder" to other lines, but in no danger of supplanting the tramway. 2500 w. St Ry Rev—March 15, 1905. No. 68613 C.

Tramways v. Motor 'Buses. Henry M. Sayers. Discusses the commercial aspects, comparing costs and carrying capacities. 2000 w. Elect'n, Lond—Feb. 17, 1905. No. 68065 A.

Types of Motor Omnibuses at the Olympia Exhibition. Descriptions, with illustrations, of various makes of motor omnibuses now on the market. 5700 w. Tram & Ry Wld—March 9, 1905. No. 68528 B.

Racing Car.

Gordon-Bennett Racers for 1905. Mr. J. Hargreaves' 80-H. P. Napier. Illustrated description of the first of the new Napier racing cars for 1905. 600 w. Auto Jour—March 18, 1905. No. 68642 A.

Review.

The Progress of Automobilism in 1904 (Les Progrès de l'Automobilism en 1904). F. Drouin. Discussing especially the lessons of the various trials and races of the year on the Continent. 1800 w. Génie Civil—Feb. 25, 1904. No. 68415 D.

Sprinkler.

Automobile Steam Sprinkling Wagon (Tonneau d'Arrosage Automobile à Vapeur). E. Bret. Illustrating a large steam sprinkler used with salt water in the streets of Paris. 2000 w. Génie Civil—March 11, 1905. No. 68447 D.

Steam Cars.

A New Steam Motor Wagon. Illustrated detailed description of a five-ton steam motor wagon made in England. 700 w. Engr, Lond—March 17, 1905. No. 68667 A.

Steam Cars at the Boston Show. H. F. Donaldson. Descriptions and photographs of types displayed. 7500 w. Automobile—March 25, 1905. No. 68616.

Swift.

The Swift Petrol Cars. Illustrates and describes the two new types of vehicle being introduced by the Swift Company. 500 w. Auto Jour—Feb. 25, 1905. Serial. 1st part. No. 68207 A.

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Trucks.

Foreign Automobile Trucks. Emile Guarini. Illustrated descriptions of some of the trucks exhibited at the Belgian Automobile Exhibition in Brussels. 1500 w. Sci Am Sup—March 25, 1905. No. 68601.

Packard 3,000-Pound Truck. Illustrates and describes a gasoline truck. 1000 w. Automobile—March 18, 1905. No. 68387.

Wheels.

Elastic Wheels. Considers the principles of action of elastic wheels intended to carry heavy loads on common roads. Does not consider wheels for motor cars and cycles. Ills. 3000 w. Engr, Lond—March 10, 1905. Serial. 1st part. No. 68544 A.

COMBUSTION MOTORS.

Carbureting.

The Carbureting of Heavy Oils. R. Desmarest. Translated from *L'Automobile*. States general laws evolved from a study of carburation, examining them successively from the point of view of their application to kerosene. 3800 w. Sci Am Sup—March 18, 1905. No. 68331.

Furnace Gas.

Commercial Possibilities of Blast Furnace Gas for the Development of Electric Power. F. du P. Thomson. Presents the advantages and disadvantages of the blast furnace gas power plant, giving details of estimated cost based on experience. Ills. 4800 w. Elec-Chem & Met Ind—March, 1905. No. 68149 C.

The Use of Coke Oven Gas in Gas Engines. An illustrated article explaining the operation of the by-product oven, the coking, the power available, its adaptability for use in engines, &c. 4500 w. Power —March, 1905. No. 68166 C.

The Use of Waste Gases in Large Gas Engines. Max Rotter. Read before the Illinois Steel Works Scientific Club. Considers the direct use of waste gases from coke ovens and blast furnaces in large gas engines. 3500 w. Ir Age—March 16, 1905. No. 68321.

Gas Engines.

Gas Blowing Engines. T. Westgarth. Gives 15 figures, with brief descriptions, and charts showing the running. 2400 w. Jour W of Scot Ir & Steel Inst—Feb., 1905. No. 68691 F.

Large Gas Engines (Gross-Gasmaschinen). A. Riedler. An exhaustive review of the development of the large gas engine, with details of construction of leading types, and a review of performance and efficiency; an important paper. 20,000 w. Zeitschr d Ver Deutscher Ing—Feb. 25, 1905. No. 68403 D.

Test of a 500 h. p. Gas Engine Using Coke-Oven Gas (Bericht über Leistungsversuche an einer 500 pferdigen Koksofengasmaschine). Dr. Eugen Meyer. Data and results of tests of an Oechelhaeuser engine, originally designed for blast-furnace gas, and altered for coke-oven gas. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 25, 1905. No. 68404 D.

The Computation of the Efficiency and Capacity of Gas Engines (Die Berechnung des Mechanischen Wirkungsgrades und der Leistung von Gasmaschinen). A. Riedler. A discussion of the correct method of computing the mechanical efficiency of a gas engine. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 25, 1905. No. 68405 D.

The Strang Gas Engine. Illustrated detailed description of a double-acting engine. 1200 w. Engr, U. S. A.—March 15, 1905. No. 68390 C.

The Ultimate Limit of Speed in Gas Engines. Herbert L. Towle. Discusses the limit imposed by engineering conditions for steady and continuous running of automobile motors, and gasoline marine engines. 3000 w. Am Mach—Vol. 28, No. 10, 1905. No. 68236.

1,200 Horse-Power Gas Engine. Illustrated detailed description of a blowing engine recently built in France. 800 w. Engr, Lond—March 17, 1905. No. 68669 A.

Gas Turbine.

Practical Investigations in the Gas Turbine Problem. Dr. Charles E. Lucke. A review of experiments in the mechanical laboratory of Columbia University, showing that the kinetic energy of expanding gases is not effectively converted into work by free expansion in simple nozzles. 2500 w. Engineering Magazine—April, 1905. No. 68725 B.

Ignition.

Action of Different Kinds of Ignition Sparks. René M. Petard. Brief explanation of the three different classes of sparks. 900 w. Automobile—Feb. 25, 1905. No. 68072.

The Spark Coil. From *Horseless Age*. Explains briefly the phenomenon of electromagnetic induction and the nature of the contact spark and the jump spark, and gives an illustrated description of the spark coil. 3800 w. Sci Am Sup—March 4, 1905. No. 68124.

Maynard Motor.

The New Maynard Internal Combustion Motor (Nouveau Moteur à Explosions ou Combustion Interieure dit Moteur Maynard). E. Maynard. A description

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of an improved internal-combustion motor in which no water jacket or other cylinder-cooling device is used. 2000 w. Rev Technique—Feb. 25, 1905. No. 68425 D.

Producer Gas.

The Gasification of Fuels in Producers, especially for the Production of Power Gas (Die Vergasung der Brennstoffe in Generatoren, insbesondere für Kraftgasbetriebe). Karl Kutzbach. A graphical analysis of the thermochemical reactions involved in the operation of gas producers. 4500 w. Zeitschr d Ver Deutscher Ing—Feb. 18, 1905. No. 68400 D.

The Riche Gas Producer in Connection with Mining Power Plants. Dr. Alfred Gradenwitz. An illustrated article giving information relating to this type of gas producer intended for generating gas from any description of wood waste as well as from similar ligneous matter, agricultural residues, &c. 1000 w. Min Rept—March 9, 1905. No. 68289.

Starting.

High-Pressure Compound Air Compressors (Hochdruck Verbundkompressoren). Describing special forms of compressors for furnishing a supply of compressed air for starting large gas engines. 800 w. Stahl u Eisen—March 15, 1905. No. 68444 D.

HEATING AND COOLING.

Indirect Coil.

Test of an Indirect Heater Coil. S. C. Root. The object of the test was to determine exactly the amount of steam condensed in an indirect coil, under varying conditions. Ills. 2000 w. Jour Assn of Engng Socs—Feb., 1905. No. 68686 C.

Office Building.

Heating and Air Washing in a Works Office Building, Pittsburg. Illustrates and describes a fan system installed in the heart of the mill district of Pittsburg. 1000 w. Eng Rec—March 18, 1905. No. 68397.

Refrigeration.

Ammonia Condensers. John Levy. Calls attention to defects in the older ammonia condensers, and considers the shell condenser the best form. Ills. 1200 w. Ice & Refrig—March, 1904. No. 68178 C.

Regulators.

Regulators for Low Pressure Steam Heating. Charles F. Hauss. Brief illustrated descriptions of some German constructions. 1400 w. Met Work—March 4, 1905. No. 68131.

Steam Heating.

Steam Heating in Connection with Condensing Engines. Reginald Pelham Bolton. Read before the Am. Soc. of Heat & Ven. Engrs. A discussion of the use of exhaust steam from condensing engines, and reporting a series of tests. 2700 w. Met Work—March 25, 1905. No. 68399.

Steam Heating Principles. Prof. William J. Baldwin. The second lecture of the course of eight on Heating and Ventilating at the Brooklyn Polytechnic Inst.'s College of Arts and Engng. Considers a closed or gravity system of steam heating in the present article. 5500 w. Sci Am Sup—March 11, 1905. No. 68251.

Ventilation.

The Ventilation of Factories and Workshops. F. S. Lister. Discusses methods by which effective ventilation is secured, especially the "Exhaust" system, and the "Plenum" system, favoring the latter. 3000 w. Builder—March 18, 1905. No. 68638 A.

HYDRAULICS.

Dynamics.

Experiments on the Dynamics of Fluids. Dr. George Finzi and Dr. Nicholas Soldati. A study of the variation of pressure, produced by a given movement, in every point of the body surface. Ills. 3800 w. Engng—March 17, 1905. Serial. 1st part. No. 68656 A.

Flow.

Flow of Water Through Pipes Fed by Reservoirs. Samuel Diescher. Describes experimental investigations, stating the conclusions. General discussion. Ills. 11700 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68569 D.

Hydraulic Power.

The Hydro-Mechanical Arrangement of Recent Austrian Electrical Stations (Hydromechanische Einrichtungen von Neueren Oesterreichischen Elektrizitätswerken). Gustav Witz. Illustrating and describing the pipe line, water-wheels, and general arrangement of the new plant on the Sill, supplying 15,000 h. p. to the city of Innsbruck. 3000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—Feb. 24, 1905. No. 68459 D.

Impulse Wheels.

Water Turbines. The present number gives a study of tangential flow. 450 w. Prac Engr—March 3, 1905. Serial. 1st part. No. 68522 A.

Meters.

See Mechanical Engineering, Measurement.

Stream Gauging.

See Civil Engineering, Measurement.

Turbines.

Comparative Experiments with Low-Pressure Reaction Turbines (Vergleichen-

de Untersuchungen an Reaktions-Niederdruckturbinen). Dr. Franz Prasil. A very complete account of experiments made at the Zurich Polytechnic upon turbines of the Francis type. Serial. Part I. 1800 w. Schweiz Bauzeitung—Feb. 18, 1905. No. 68496 B.

MACHINE WORKS AND FOUNDRIES.

Boring Mill.

A New Boring Mill. Illustrates and describes a mili of the extension type. 800 w. Am Mach—Vol. 28, No. 10. No. 68238.

Cams.

The Layout and Construction of Cams. Charles F. Smith. Explains the order of work when laying and making cams, the design of a cam operated machine, laying out a single cam, &c. Ills. 3000 w. Am Mach—Vol. 28, No. 11. Serial. 1st part. No. 68322.

Car Shop Tools.

Tools Used in the United States for Railroad Car Work (Outils Employés aux Etats Unis pour l'Usinage des Roues de Voitures et Wagons). M. Oudet. An illustrated description of wheel lathes, slotters, boring mills, and other tools of American design for car-shop work. 7500 w. Rev Gen de Chem de Fer—Jan., 1905. No. 68431 G.

Castings.

Casting Round Flasks in Cores. H. J. M'Caslin. Illustrates and describes a method of casting round flasks of large diameter in cores with satisfactory results. 500 w. Foundry—March, 1905. No. 68097.

The Defects in Ingot-Iron Castings. Prof. K. Hermann Wedding. Special consideration of the open-hearth process, considering blow-holes, shrinkage cavities, air bubbles, steam cavities, surface cracks, &c. Ir & Steel Mag—March, 1905. No. 68510 D.

Chains.

A New Belgian Process of Manufacturing Weldless Chains. Emile Guarini. Illustrates and describes a process of annular rolling, due to M. Massin. 1300 w. Sci Am Sup—March 11, 1905. No. 68252.

Core Ovens.

Automatic Core Ovens Using Oil as Fuel. S. E. Barnes. Read before the Phila. Found. Assn. Describes a system for burning oil which has been found safe, economical and convenient. Short discussion. 1800 w. Foundry—March, 1905. No. 68098.

Cranes.

Seventy-Ton Electric Travelling Crane. Illustrated description of an electric traveller and gantry which has been constructed for the Natal Government. 500 w. Eng, Lond—March 10, 1905. No. 68547 A.

The Graphical Analysis of a Simple Jib Crane. A. L. Westcott. An explanation of graphic statics as applied to a jib crane. 800 w. Am Mach—Vol. 28, No. 12. No. 68579.

Dies.

Die and Bender for Circuit Breaker Clips. W. F. Hoffman. Illustrated description. 400 w. Am Mach—Vol. 28, No. 11. No. 68325.

Drafting.

Bridge Office Drafting Rules. H. G. Tyrrell. Gives rules drawn up as a general guide, which may be modified to suit particular cases. 5500 w. Eng News—March 23, 1905. No. 68582.

Drafting Room Practice. Ralph E. Flanders. Shows some of the ways in which the drafting room may lighten the labors of the workmen, and advance the industry. Considers the routine office work of a typical shop. 6000 w. Mach, N. Y.—March, 1905. No. 68162 C.

Electric Driving.

Electric Driving in Wood-Working Shops. Results of a series of experiments, carried out for determining the power required for various wood-working machine tools under different conditions. 1800 w. Elect'n, Lond—Feb. 3, 1905. No. 68138 A.

Electrical Works.

The Brush Electrical Engineering Company's "Falcon" Works. Illustrated detailed description. 1500 w. Elec Rev, Lond—March 17, 1905. Serial. 1st part. No. 68650 A.

The Western Electric Co.'s Factory, North Woolwich. Illustrates and describes these works which have recently made extensive changes. 3000 w. Elec Rev, Lond—March 3, 1905. No. 68304 A.

Flywheels.

Boring, Turning and Keyseating Flywheels on a Pit Lathe. Illustrated description of the application of a pit lathe to flywheel making. 700 w. Am Mach—Vol. 28, No. 10. No. 68239.

Foundry Methods.

Foundry Methods of the Landis Tool Company. F. A. Halsey. Illustrates and describes various methods of work of particular interest. Molding, chilling process, &c. 1700 w. Am. Mach—Vol. 28, No. 9. No. 68100.

Grinding.

Improved Protection Devices for Artificial Grinding Wheels (Nouveaux Protecteurs pour Meules Artificielles). Henri Manny. Illustrated descriptions of the

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devices receiving the prizes of the Association of French Workmen against accidents. 1500 w. 1 plate. Génie Civil—March 4, 1905. No. 68416 D.

Modern Commercial Grinding. W. Muston. Abstract of a paper read before the Birmingham Assn. of Mech. Engrs. Deals with plain or taper cylindrical work, ground on its external surface. 4500 w. Mech Engr—March 11, 1905. No. 68523 A.

Some English Grinding Machinery. Illustrated descriptions of recent English types. The most distinctive features are the self-oiling-dust proof bearings, which are extra long and of a large diameter, and driving pulleys, which are extra wide and of large diameter. 900 w. Ir Age—March 9, 1905. No. 68241.

Tool Grinders. T. S. Bentley. Briefly traces the history of tool grinding, and considers the cutting power of a wheel, the various substances of which wheels are made, their wear, &c. 3800 w. Prac Engr—Feb. 24, 1905. Serial. 1st part. No. 68208 A.

Hardening.

A New Hardening Furnace. Illustrates and describes a furnace invented by S. N. Brayshaw, which makes use of a salt bath for heating the work. 800 w. Am Mach—Vol. 28, No. 11. No. 68326.

High Speed Tools.

New Machine-Tools for High-Speed Steel (Neue Werkzeuge für Hohe Arbeitsgeschwindigkeit). Alfred Haussner. A discussion of modern methods of cutting with high-speed steels, and their influence upon machine-tool design. 7000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 4, 1905. No. 68705 D.

Lathes.

Heavy Turret-Lathe for 6-in. Black Steel Bars. Illustrated detailed description of a very powerful turret-lathe designed to take full advantage of the cutting capacity of modern tools. Built at Cleveland, Ohio. 1200 w. Engng—March 17, 1905. No. 68660 A.

Lathe for Rotors of Large Steam Turbines at Clydebank, N. B. Illustrations, with brief description. 450 w. Engng—March 10, 1905. No. 68542 A.

Milling Machine.

Vertical Spindle Milling Machine with Constant Speed Drive. Illustrated description of a new machine and its operation. 1200 w. Am Mach—Vol. 28, No. 9. No. 68103.

Molding.

Making a Spiral Drum in Loam. Joseph Horner. An illustrated detailed description of the molding of a large spiral drum, or screw barrel, for a powerful Titan crane. 2500 w. Foundry—March, 1905. No. 68099.

Molding Crooked to Make Straight Castings. Thomas Mack. Describes method used to overcome warping. Ills. 800 w. Am Mach—Vol. 28, No. 10. No. 68240.

Molding a Rope Drive Flywheel. R. H. Palmer. Illustrates and describes the method used. 900 w. Am Mach—Vol. 28, No. 11. No. 68324.

Moulds.

Facing Moulds for the Production of Fine Surface Castings. Directions for preparing the moulds for finely finished castings. 1200 w. Prac Engr—Feb. 17, 1905. No. 68060 A.

Notching.

An Armature Disk Notching Attachment. H. B. M'Cabe. Illustrated detailed description of the attachment and its working. 900 w. Am Mach—Vol. 28, No. 10. No. 68237.

Planer.

A New Variable Speed Planer with Air-Actuated Friction Clutches. Illustration, with description. 1200 w. Am Mach—Vol. 28, No. 9. No. 68101.

96-Inch Planer, with Friction Clutches, Operated by Air. Illustrated description of a planer intended for work not exceeding 96 ins. wide, 96 ins. high and 20 ft. long. 1100 w. Ry & Loc Engng—March, 1905. No. 68158 C.

Shops.

See Railway Engineering, Permanent Way and Buildings.

Tool Design.

The Rational Design of Machine Tools. Editorial comment on a recent lecture by Prof. J. T. Nicolson before the graduates of the Inst. of Mech. Engrs. on "Results of Force Measurements with Cutting Tools and the Application to Lathe Design." 2000 w. Engng—Feb. 24, 1905. No. 68220 A.

Wheel Foundry.

The New Wheel Foundry of the Pennsylvania at Altoona. Illustrated detailed description of new works and their equipment. 3800 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68370.

Woodworking.

Universal Woodworking Machine. Illustrated description of a new type of machine which can be applied to a variety of purposes, such as trenching, recessing, cross-cutting, grooving, moulding, &c. 1200 w. Engng—Feb. 24, 1905. No. 68223 A.

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Works-Laboratory.

Labor Saving Appliances in the Works-Laboratory. Edward Keller. Illustrates and describes appliances introduced in the laboratory of the Anaconda Copper Mining Co., in Baltimore, Md. 3500 w. Am Inst of Min Engrs—March, 1905. No. 68568.

MATERIALS OF CONSTRUCTION.

Blackings.

Foundry Blackings. N. W. Shed. Information in regard to the various kinds of blackings used and the work for which they are suited, method of testing, &c. 1200 w. Foundry—March, 1905. No. 68095.

Brasses.

Practical Methods of Analysis for Brasses and Bronzes. W. W. Corse. Explains methods of analysis and their importance in the brass foundry. 2000 w. Foundry—March, 1905. No. 68096.

Bronze.

A Special Constituent Obtained by Tempering Aluminum Bronze (Constituant Spécial Obtenu dans la trempe d'un Bronze d'Aluminium). Pierre Breuil. Describing an especial crystalline form occurring in alloys of copper and aluminum when tempered at 650 to 750 degrees C. 1000 w. Comptes Rendus—Feb. 27, 1905. No. 68421 D.

Cast Iron.

Specifications for Cast Iron (Vorschriften für die Lieferung von Gusseisen). A. Martens. A review of the specifications of the German Society of Foundrymen by the director of the Charlottenburg testing laboratory. 4000 w. Zeitschr d Ver Deutscher Ing—March 11, 1905. No. 68446 D.

Corrosion.

The Corrosion of Metals. Prof. A. H. Sexton. A discussion of the corrosion of metals in common use under the conditions in which they are most generally used, and the means that have beeen found most efficient for protecting them. 2500 w. Mech Engr—Feb. 18, 1905. Serial. 1st part. No. 68061 A.

Impact Testing.

Impact Testing of Notched Bars. Illustrates and describes two recent types of machine invented by M. G. Charpy, which he considers will meet the requirements of all practical cases. 2000 w. Engr, Lond—March 10, 1905. No. 68548 A.

Metallography.

Equipment and Work of Metallographical Laboratories in Germany. E. P. Buffet. Extracts from descriptions appearing in German engineering periodicals, describing two recent plants. 1800 w. Ills. Am Mach—Vol. 28, No. 11. No. 68323.

Notes on the Etching of Steel Sections. William Cobb Smeaton. Discusses the four general classes of etches: Heat-tinting; electro-deposition; polishing in bas-relief; solvent etches. 2500 w. Ir & Steel Mag—March, 1905. No. 68511 D.

The Scientific Development of the Art of Polishing (Les Enseignements Scientifiques du Polissage). MM. F. Osmond & G. Cartaud. A discussion of modern methods of producing a high polish upon metallic surfaces in connection with researches into the physical structure of materials. 5000 w. Rev Gen des Sciences—Jan. 30, 1905. No. 68702 D.

Pig Iron.

A Classification System for Foundry Pig Iron (Klassifikations Vorschläge für Giessereiroheisen). Dr. Wüst. A discussion of the composition and properties of German irons and a proposition to grade them according to the use to which the castings are to be applied. Three articles. 9000 w. Stahl u Eisen—Feb. 15, March 1, 15, 1905. No. 68437 each D.

Pig-Irons and Their Use in the Foundry and Forge. E. Adamson. Abstract of a paper read before the Manchester Assn. of Engrs. Gives table showing the sources of ore supply, and discusses hematite pig-iron, quality, grading, &c. Ir & Coal Trds Rev—March 3, 1905. No. 68319 A.

Pipe.

Steel and Iron Wrought Pipe. Frank N. Speller. Read at meeting of the Can. Min. Inst. Reviews the results of investigations made of threading and relative durability. Ills. 3000 w. Ir Ag—March 2, 1905. No. 68087.

Steel.

Special Steels (Aciers Speciaux). J. Malette. A general and systematic review of modern alloy steels, with tabular view of their composition and properties. 2000 w. Rev Technique—Feb. 25, 1905. No. 68426 D.

Steel as Applied to Motor Car Construction. J. S. Critchley. Excerpt from a paper read before the Automobile Club (London). The difficulties in annealing, testing, vanadium steel, &c. 1500 w. Auto Jour—March 11, 1905. No. 68521 A.

Steel Protection.

Protecting Steel Structures. Reports the results of interesting experiments of Louis H. Barker, the testing of paints, and the success obtained by using paraffin paper as a substitute for covering metal. Ills. 1500 w. Ry Age—March 24, 1905. No. 68672.

We supply copies of these articles. See page 319.

Stresses.

The Bending Stresses in Curved Prismatic Bodies (Beitrag zur Bestimmung der Biegungsspannung in Gekrümmten Stabförmigen Körpern). Ernst Werner. An analytical examination of the stresses on loaded beams when curved. 1800 w. Zeitschr d Ver Deutscher Ing—Feb. 18, 1905. No. 68402 D.

Torsion.

The Deformation Work in Torsion (Zur Frage: Formänderungsarbeit bei Torsion). Prof. Zschetzsche. A mathematical discussion, deriving formulas for computing the work of torsion for bodies of various sections. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 11, 1905. No. 68706 D.

Wire Ropes.

Bending Stresses in Wire Ropes. Samuel Diescher. Relates to bending stresses as they occur in the wires of ropes bent around sheaves in the operation of hoisting machinery, inclined planes, cable railways, &c. Ills. Discussion. 4000 w. Pro Engrs' Soc of W Penn—Feb., 1905. No. 68090 D.

The Use and Abuse of Wire Rope. L. C. Moore. The discussion is confined to cast steel and the higher grades of wire rope. Gives explanation of the methods of preparing wire for these grades. 4000 w. Pro Engrs' Soc of W Penn—Feb., 1905. No. 68091 D.

MEASUREMENT.

Friction.

A Note on Sliding Friction (Sur le Frottement de Glissement). L. LeCornu. A paper before the French Academy, showing that the consideration of the elasticity of the material explains the apparent inconsistencies in Coulomb's law. 1000 w. Comptes Rendus—March 6, 1905. No. 68449 D.

Metric System.

Metric System in Great Britain. Report of the Decimal Association. (Abstract.) Considers British legislation on this subject, the action taken by various associations, &c. 2000 w. Am Mach—Vol. 28, No. 9. No. 68104.

Recorders.

Registering Errors of Recording Levers (Erreurs d'Inscription des Leviers Enregisteurs). F. Cellerier. An examination of the causes of error in multiplying levers, such as are used in indicators, barographs, testing-machine recorders, etc. 7500 w. Revue de Mécanique—Jan. 31, 1905. No. 68464 E + F.

Testing-Machine.

A New Testing-Machine for Reversals of Stress. J. H. Smith. Brief account, with illustrations, of a machine which is to form a part of the Mechanical Engineering Department of the Municipal Technical Inst. of Belfast. 1500 w. Engng—March 10, 1905. No. 68541 A.

Water Meters.

The Measurement of Water (Le Jaugeage de l'Eau). A description of the Venturi meter, and its applications in England and on the Continent in connection with the metering of municipal water supplies. 2500 w. Revue Technique—Feb. 10, 1905. No. 68423 D.

POWER AND TRANSMISSION.

Brakes.

More Notes on Band Brake Design. C. F. Blake. Considers the holding power due to the wedging of the blocks in the V-grooved brake wheel. Diagrams. 1500 w. Mach, N. Y.—March, 1905. No. 68160 C.

Cableway.

Cableways and Railways (Seilbahn und Eisenbahn). A description of a very Extensive Cableway installation, conveying iron ore from the Anmetz mine to the Friede furnace at Kneuttingen, the capacity being 5½ ton-kilometres per year. 1800 w. 1 plate. Stahl u Eisen—March 1, 1905. No. 68438 D.

Erecting Radial Cableways for Gold Mining in Mexico. Illustrated description of an installation of two 800-ft. radial traveling cableways, each with a capacity of 100-yds. of gravel per hour, for stripping gold-bearing gravels from the bottom of cañons. 1200 w. Eng Rec—March 11, 1905. No. 68267.

Clutch.

An Improved Clutch (Sur un Nouvel Embrayage). M. Hérisson. Describing an improved form of friction clutch giving gradual engagement without excessive wear from sliding friction. 1000 w. Comptes Rendus—Feb. 6, 1905. No. 68418 D.

Compressed Air.

Graphics of Boyle's Law. E. F. Schaefer. A discussion of the law of the relations of pressure and volume of compressed air and other gases, showing the method of plotting them as a graphical diagram. 1500 w. Air Power—April, 1905. No. 68728.

Ignitions and Explosions in the Discharge Pipes and Receivers of Air Compressors. Alex. M. Gow. A report of extensive investigation undertaken to ascertain what precautions should be taken to guard against such accidents. A valuable paper. 5700 w. Eng News—March 2, 1905. No. 68113.

We supply copies of these articles. See page 319.

Specifications for an Air Compressor. Gives specifications for an air compressor for an air-life pumping plant at Spring Lake, N. J. 1500 w. Eng News—March 2, 1905. No. 68114.

Electric Driving.

An Induction-Motor Factory Installation. Illustrated description of the new electrical generating and distribution system of the New York Glucose Co., at Edgewater, N. J. 2500 w. Elec Wld & Engr—March 18, 1905. No. 68535.

Electric Motor Equipment of the Worthington Hydraulic Works. Illustrated description of a new plant in Harrison, N. J. 2400 w. Elec Wld & Engr—March 18, 1905. No. 68537.

Electric Power Equipment of a Modern Machine Shop. Illustrates and describes the electrical equipment of the Link-Belt Engineering Co., near Philadelphia. Examples of both individual motor and group driving. 3000 w. Elec Wld & Engr—March 18, 1905. No. 68536.

Electric Power in Factories. A. W. Henshaw. Considers the reasons for the growing popularity of this system, giving information helpful in determining the system best adapted to any given condition. 6000 w. Elec Wld & Engr—March 18, 1905. No. 68533.

Individual Motor-Drive in a Type Foundry. Illustrates and describes the application of individual motor drives for small machines at the factory of the American Type Founders' Company, at Communipaw, N. J. 2500 w. Elec Wld & Engr—March 18, 1905. No. 68532.

The Application of Electric Motors to Machine Tools. George T. Hanchett. Presents the advantages of driving tools directly by motors, considers variable speed control, and the methods. 3300 w. Elec Wld & Engr—March 18, 1905. No. 68531.

The Application of Electricity to a Large Manufacturing Industry. Illustrated description of the new manufacturing plant of the Ingersoll-Sergeant Drill Company. 2000 w. Elec Wld & Engr—March 18, 1905. No. 68534.

Gas Pumping.

Natural Gas Pumping Plant at Hundred, W. Va. An illustrated description of the pumping plant of the Carnegie Natural Gas Company, erected by the Rand Drill Company, delivering 30,000,000 cubic feet of gas from West Virginia to the works of the U. S. Steel Corporation in the vicinity of Pittsburgh, Pa. 2000 w. Air Power—April, 1905. No. 68726.

Link Belts.

The Transmission of Power by Means of Link Belts. A. B. Morrison, Jr. An illustrated explanation of the action of block chains, roller chains, and silent chains, with suggestions on the selection for any particular installation. 4000 w. Engr, U. S. A.—March 1, 1905. No. 68155 C.

Power Cost.

The Cost of Installation and Operation of Various Sources of Power (Spese di Impianto e di Esercizio di Diversi Sistemi per la Produzione dell' Energia). A comparison of the costs of motive power derived from steam engines, steam turbines, Diesel motors, and gas engines. 3000 w. L'Ingegneria e l'Industria—Feb. 15, 1905. No. 68713 D.

Ropes.

A New Scheme in Rope Transmission. George F. Willis. Illustrated description of a new system which can be applied to a drive using any number of ropes. 900 w. Power—March, 1905. No. 68170 C.

Rope Driving. C. Boysen. Discusses the application of hemp ropes for the transmission of power, its advantages, the two systems in use, &c., giving formulas and equations for solving problems of rope drives. 1500 w. Power—March, 1905. No. 68168 C.

Shafts.

Combined Bending and Torsion in Shafts. George A. Lister. Explains method of proportioning in designing shafts subjected to both bending and twisting moments. 800 w. Mech Engr—March 4, 1905. No. 68300 A.

Telpherage.

Transportation of Materials by Electricity. A. Frederick Collins. Illustrates and describes the equipment installed at the works of the Baker Chocolate Company, at Milton, Mass., where overhanging electric telpher trains convey materials used. 1200 w. Sci Am—March 18, 1905. No. 68328.

Windmills.

Powerful German Windmills. Charles B. Hayward. Illustrations, and descriptions, of interesting types. 1600 w. Sci Am—March 25, 1905. No. 68598.

The Old Dutch Windmill at Golden Gate Park, San Francisco. An illustrated article considering the features of engineering interest in the construction of this windmill, which is the largest wind motor in the United States. 4500 w. Jour of Elec—March, 1905. No. 68286 C.

Worm Gearing.

Worm-Gear Transmission for Electric Tramway Cars (Emploi des Vis sans Fin dans les Transmissions des Tramways Electriques). H. Somach. Details of a successful electric truck with worm gear

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transmission, designed by the Oerlikon Works. 1000 w. 1 plate. Génie Civil—March 11, 1905. No. 68448 D.

STEAM ENGINEERING.

Adiabatics.

Determination of Exponents of Adiabatics. Thomas M. Gardner. Showing that no simple relationship exists between the values of adiabatic exponents and specific, latent or total heats. 1100 w. Jour Fr Inst—March, 1905. No. 68345 D.

Boilers.

Difficulty of Combining Efficiency of Boilers with Their Safe Working. C. E. Stromeyer. Read before the Leeds Univ. Engng. Soc. Discusses the troubles due to high temperatures and the possibility of remedying them. 2500 w. Prac Engr—Feb. 24, 1905. No. 68209 A.

Chimneys.

Chimneys. F. H. Davies. Discusses the questions that must be studied in properly designing chimneys. 1700 w. Elec Engr, Lond—March 10, 1905. No. 68525 A.

Coal Testing.

Testing Coals and Lignites at the St. Louis World's Fair. Edward W. Parker. The first portion of a complete review of the equipment and work of the coal-testing plant of the United States Geological Survey at St. Louis. 4000 w. Engineering Magazine—April, 1905. No. 68721 B.

Condensers.

Central Condensing Plant at Neuves Maisons (Zentral - Oberflächenkondensation in Neuves Maisons). Fr. Frolich. Illustrated description of the new central condensing plant of the Chatillon, Commentry Co., capable of condensing 125,000 kilogrammes of steam per hour. 3000 w. Zeitschr d Ver Deutscher Ing—Feb. 18, 1905. No. 68401 D.

Cylinder Dimensions.

Cylinder Dimensions and Engine Economy. Sterling H. Bunnell. Gives diagrams, illustrating the principles governing the wire selection of the dimensions for an engine, with explanatory remarks. 2400 w. Power—March, 1905. No. 68169 C. 1905. No. 68346 D.

Engine Bearings.

Adjustment and Alloys for Engine Shaft Bearings. William Turner. Abstract of a paper read before the Manchester (Eng.) Assn. of Engrs. 1800 w. Engr, U. S. A.—March 15, 1905. No. 68391 C.

Engines.

Compound Corliss Spinning Mill Engine. Illustrated description of a fine example of a modern British mill engine. 2400 w. Engr, Lond—March 3, 1905. No. 68313 A.

Main Engines of the American Steamship Dakota. Illustrated detailed description of engines of more than usual interest. 2000 w. Marine Rev—March 16, 1905. No. 68500.

The Modern Horizontal Steam Engine as Exemplified in British Practice. Leo. H. Jackson. Gives illustrated descriptions of designs manufactured as standard types by British makers. 3500 w. Cassier's Mag—March, 1905. Serial. 1st part. No. 68127 B.

Evaporation.

Multiple Effect Evaporation. Charles Day. Read before the Manchester Assn. of Engrs. Describes the principles on which the system of multiple evaporation is based, and gives illustrations of its application in daily practice. 3400 w. Mech Engr—Feb. 18, 1905. No. 68062 A.

Feed Water.

A Simple Method of Calculating Water Analyses and Amounts of Substances to be Added for Preventing Scale and Corrosion of Boilers. Samuel S. Sadtler. Gives curves and tables which are applicable to several schemes of analysis, and save time. 1200 w. Jour Fr Inst—March,

The Chemical Purification of Boiler Feed-Water. George E. Walsh. A discussion of the different treatments of impure feed-water for boilers, and of water-softening and purifying machines. 1500 w. Am Elect'n—March, 1905. No. 68140.

Flow.

The Theory of the Flow of Elastic Fluids and the Divergent Nozzle. M. Blieden. A mathematical study. 3000 w. Engr, Lond—Feb. 17, 1905. Serial. 1st part. No. 68057 A.

Fuel Waste.

Loss of Fuel by Presence of Combustible in Refuse. Hartley Le Huray Smith. Gives a method of calculating the fuel wasted and the graphical representation of it by a curve sheet covering ordinary practice. 500 w. Power—March, 1905. No. 68173 C.

Lubrication.

The Lubrication of Steam Engines and Machinery. Considers an example showing the loss due to low efficiency, and discusses the lubrication of cylinders and valves and the motion work of engines. 2000 w. Mech Engr—Feb. 25, 1905. Serial. 1st part. No. 68210 A.

Oil Fuel.

On the Economy of Steam Power Plants Using Oil Fuel. Presents tables and calculations referring to maximum economy under duty trial, explaining methods. 2800 w. Jour of Elec—March, 1905. No. 68287 C.

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Pipes.

Steam Pipes. R. T. Strohm. Considers only the main steam pipes to and from the engines, discussing the selection of material and its erection, method of determining the loss of pressure to be expected, arrangements, tight joints, etc. 1800 w. Am Elect'n—March, 1905. No. 68142.

Safety Valves.

High-Lift Safety Valves (Sicherheitsventile, Insbesondre Solche mit Hohem Hub). P. H. Rosenkranz. An examination of the forms of valves and seats best adapted to give effective relief to steam pressure. 2500 w. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68408 D.

Specific Heat.

The Calorific Properties of the Vapor of Water at High Temperatures (Die Kalorischen Eigenschaften des Wassers und seines Dampfes bei Hohen Temperaturen). C. Dieterici. A discussion of the determination of the specific heat of water and of superheated steam. 3500 w. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68409 D.

Superheating.

A Compound Superheater. R. Hildebrand. An account of the power plant of the tramway station, Luisenstrasse, Berlin, Germany, which has a maximum capacity of 12000 h.-p., using separately fired superheaters. Diagrams. 900 w. Power—March, 1905. No. 68174 C.

Superheater Duties and Design. Franz Koester. A detailed account of a test made at the municipal plant in Manheim, Germany, in which Herring superheaters were used. 1200 w. Power—March, 1905. No. 68172 C.

The Superheating of Steam and its Influence on Engine Economy. R. M. Neilson. The second paper discusses the results secured by the use of superheated steam, with data and results of tests. 4000 w. Engineering Magazine—April, 1905. No. 68724 B.

Turbines.

Impulse and Reaction Turbines. An illustrated article explaining the distinction between the impulse and reaction turbine. 1200 w. Mach, N Y—March, 1905. No. 68161 C.

Reports on Tests of a Centrifugal Pump and a "Sirocco" Blower Driven by De Laval Steam Turbines. Illustrates and describes apparatus used, and methods of testing, giving results. 4500 w. Jour Am Soc of Nav Engrs—Feb., 1905. No. 68515. H.

Steam Turbines (Dampfturbinen). Johann Trnovsky. A general account of the principles of steam-turbine design, with illustrations of the leading commercial types. Two articles. 6000 w. 1 plate. Oesterr Wochenschr f d Oeffent Baudienst—Jan. 14, 21, 1905. (No. 68704 each D.

The Determination of the Elements of Steam Turbines (Determination des Eléments des Turbines à Vapeur). M. Kopp. Applying the method of Boulvin to the construction of the entropy diagram for the turbine in connection with problems of design and proportion. 7500 w. Revue de Mécanique—Feb. 28, 1905. No. 68466 E + F.

The Phenomena of Flow in the Nozzles of Steam Turbines (Les Phénomènes d'Econlement dans les Tuyères des Turbines à Vapeur). A. Koob. A translation of the paper of Koob from the German, showing the application of the temperature-entropy diagram to turbines. 3500 w. Revue de Mécanique—Jan. 31, 1905. No. 68465 E + F.

Valves.

Locomotive Valves and Valve-Gears. W. F. M. Goss. Explains the requirements, and describes the Stephenson valve-gear, discussing its merits and defects. Improved valve gears, valve setting, foreign valve-gears, etc., are also briefly considered. 5500 w. Pro S & S-W Ry Club—March 16, 1905. No. 68341 E.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

The Anthracite Coal Fields of Pennsylvania. Arthur H. Storrs. A description of these deposits, with information concerning the methods of mining, and other matter of interest. Ills. 3000 w. Min Mag—March, 1905. No. 68355 C.

The Preparation of Anthracite. Notes the changes that have taken place in the practice during the past twenty-five years. Ills. 2300 w. Mines & Min—March, 1905. No. 68229 C.

Briquettes.

Briquetted Fuels, Foreign and Domestic. G. M. Randall. Gives a brief resumé con-

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cerning the manufacture of artificial fuel in several foreign countries, and matters of related interest. 4000 w. Power—March, 1905. No. 68167 C.

Coal Field.

The Tug River Coal Field. Henry M. Payne. A description of the general geology of the region and of the qualities of the coal. 1000 w. Ills. Mines & Min—March, 1905. No. 68230 C.

Coal Regions.

Seaboard Coal Regions Along the Baltimore and Ohio Railroad. Beverley S. Randolph. Report of the Fairmont, Tunnelton, Georges Creek, and Meyersdale regions. Ills. 1500 w. Min Mag—March, 1905. No. 68357 C.

The Ohio and Indiana Coal Fields. George A. Ashley. Describes the deposits and method of mining. Ills. 1400 w. Min Mag—March, 1905. No. 68358 C.

Coal Testing.

See Mechanical Engineering, Steam Engineering.

Coke.

The Connellsville Coke Region. Thomas W. Keighley. A description of this region, the deposits, method of mining, the coke ovens, and report of a flourishing condition. 3800 w. Min Mag—March, 1905. No. 68356 C.

The Making of By-Product Coke. Edwin A. Moore. Abstract of an address to the Phila. Found. Assn. Remarks on the rapid replacement of beehive ovens by-product ovens, describing the operation of a plant at Camden, N. J. 1100 w. Eng & Min Jour—March 2, 1905. No. 68135.

To Purify Pit Water at Coke Works. A brief explanation of the system devised by Prof. John W. Langley. 800 w. Ir Trd Rev—March 23, 1905. No. 68590.

Colorado.

Coals of the Southern Colorado or the Walsenburg and Trinidad Region. A. Lakes. Describes the location of the deposits and the composition of the coal. Ills. 1400 w. Min Rept—March 2, 1905. No. 68203.

The La Plata or Southwestern Colorado Coal Field. A. Lakes. Describes the geology and the deposits of this region. Ills. 1400 w. Min Rept—Feb. 23, 1905 No. 68076.

Conveyors.

Mechanical Coal Conveying at the Face, with Especial Reference to the "Blackett" Conveyor and Its Work at Derwent Colliery, Co. Durham. Harry Palmer. From the *Jour. of the Brit. Soc. of Min. Students.* Ills. 1800 w. Ir & Coal Trds Rev—March 17, 1905. No. 68655 A.

Electric Power.

Application of Electric Power in Collieries. G. M. Brown. Abstract of a paper read before the Rugby Engng. Soc. Discusses the advance in the application of electricity to mining due to the introduction of the polyphase alternating current induction motor. 2700 w. Elect'n, Lond—March 17, 1905. No. 68653 A.

Explosions.

Coal-Mine Explosions in Kansas. Report of a commission appointed to investigate the causes. 2000 w. Eng & Min Jour—March 16, 1905. No. 68362.

Flat Top.

Flat Top Mine. Samuel H. Lea. Describes a typical coal mine in the Birmingham, Ala., district, with the characteristics and manner of working. 3500 w. Mines & Min—March, 1905. No. 68233 C.

Haulage.

High-Tension Underground Haulage-Gear. Illustrates and describes the electric haulage recently installed at Durham collieries. 1100 w. Engng—March 17, 1905. No. 68659 A.

Illinois.

The Illinois Coal Field. George S. Rice. Gives location of the deposits, describing methods of mining. 1200 w. Min Mag—March, 1905. No. 68359 C.

Montana.

The Montana Coal Fields. J. P. Rowe. Illustrated description, with account of mining methods and machinery, and remarks on their commercial value. 3500 w. Min Mag—March, 1905. No. 68360 C.

Power Plants.

Economy in the Operation of Coal-Mine Power Plants. F. C. Weber. A discussion of the superiority of the Corliss type of engine over other forms for use in mining power plants. 1200 w. Air Power—April, 1905. No. 68728.

Wyoming.

Rock Springs Coal Mines in Wyoming. Prof. Arthur Lakes. Notes on the formations, the mines, and methods of mining. 2000 w. Mines & Min—March, 1905. No. 68231 C.

COPPER.

British Columbia.

Copper Deposits of the Aspen Grove Camp, Similkameen, Brtish Columbia. Frank Bailey. An illustrated description of this camp, its geological features, deposits, development, etc., with an outline of its history. 1400 w. Min Rept—Feb. 23, 1905. No. 68077.

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Flue Dust.

Flues and Flue Dust at Anaconda. C. H. Dougall. Read before the Can. Soc. of Civ. Engrs. Sketches and description of arrangements of the plant which are giving most satisfactory results, and related matters of interest in connection with this copper smelter. 4000 w. Can Min Rev—Feb., 1905. No. 68080 B.

Slag-Car.

A Special Form of Slag-Car. L. J. W. Jones and B. H. Bennetts. Illustrated description of a car in use at the copper blast-furnaces at Tacoma, Wash. 1200 w. Am Inst of Min Engrs—March, 1905. No. 68563.

Stamp Mill.

The Baltic Stamp Mill: Lake Superior Copper Region. Illustrated detailed description of a recently completed mill at Redridge, Mich. 2500 w. Eng News—March 23, 1905. No. 68580.

GOLD AND SILVER.

Alaska.

A Growing Camp in the Tanana Gold Fields, Alaska. Sidney Paige. An account of life and conditions at the Fairbanks camp. Ills. 2500 w. Nat Geog Mag—March, 1905. No. 68225 C.

The Placer Fields of North-Western America. Thomas Tonge. Information obtained from Chester Wells Purington, who recently investigated the placer mining industry of Alaska, in regard to the conditions, cost of mining, and best methods to employ in the different districts. 4000 w. Min Jour—March 18, 1905. No. 68637 A.

Assaying.

On Cupellation and Parting in Ore Assaying. T. Kirke Rose. Notes on methods adopted in the assay of gold ores. 1500 w. Jour Chem, Met & Min Soc of S Africa—Jan., 1905. No. 68517 E.

Bohemia.

Gold Mining at Roudny in Bohemia (Der Golderzbergbau am Roudny in Böhmen). Dr. Oskor Eypert. Describing the application of the modern cyanide process to an old gold working in Bohemia. Two articles. 5000 w. Oesterr Zeitschr f Berg u Huttenwesen—Feb. 18, 25, 1905. No. 68694 each D.

British Columbia.

Mining on Gribble Island, B. C. W. M. Brewer. An account of the geology, characteristics of the gold-bearing ore bodies, development, &c. 1600 w. Min & Sci Pr—March 18, 1905. No. 68634.

Chlorination.

The Effect of Silver on the Chlorination and Bromination of Gold. H. O. Hofman and M. G. Magnuson. An account of a research to find the dissolving power of chlorine-water and of bromine-water upon gold and upon a series of alloys of gold and silver, the operations being carried out in revolving vessels. 3300 w. Am Inst of Min Engrs—March, 1905. No. 68567.

Cyaniding.

Cyanidation of Silver in Mexico. Hugh G. Elwes. Gives reports of experiments showing that a profit can be made where no other available process can give satisfaction. 1000 w. Eng & Min Jour—March 16, 1905. No. 68366.

Laboratory Experiments on the Use of Ammonia and Its Compounds in Cyaniding Cupriferous Ores and Tailings. A. Jarman and E. LeGay Brereton. Read before the Inst. of Min. & Met. A record of valuable experiments made in connection with the treatment of gold ores containing up to 1½ per cent. of copper. 700 w. Min Rept—March 9, 1905. No. 68290.

Relative Merits of Wet and Dry Crushing in Cyanidation. Paul Danckwardt, in Trans. Black Hills Min. Assn. Gives an outline of the leading points which determine the selection of the proper kind of machinery to be used at a mill. 1300 w. Min & Sci Pr—March 11, 1905. No. 68503.

Dredging.

Dredging for Fine Gold in Idaho. Robert N. Bell. Describes the method employed to recover fine gold from the Snake River placer beds. 2000 w. Min Wld—March 11, 1905. No. 68294.

Grinding.

The Influence of Fine Grinding on the Metallurgy of the Precious Metals. A. W. Warwick. Read before the West. Assn. of Tech. Chem. & Met. Discusses recent changes in methods of treating gold ores, the treatment of slimes, and describes machines for fine grinding. Ills. 1200 w. Min Rept—March 2, 1905. Serial. 1st part. No. 68501.

Mexico.

El Oro District, Mexico. Robert T. Hill. An illustrated account of the largest and most important gold-mining camp of Mexico. 3000 w. Eng & Min Jour—March 2, 1905. No. 68133.

Nevada.

The Goldfield District, Nevada. M. D. Draper. An illustrated account of this district, its location, geology, deposits, &c. 4000 w. Min & Sci Pr—March 11, 1905. No. 68502.

Ore Bodies.

Features of the Occurrence of Ore at Red Mountain, Ouray County, Colo. T.

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E. Schwarz. Describes certain sections of the Yankee Girl mine, which throw additional light on the geology of this section. Reference is made to the report of F. L. Ransome. Ills. 1800 w. Am Inst of Min Engrs—March, 1905. No. 68561.

Ore Treatment.

Crushing and Cyanidation. F. C. Roberts. Gives results of recent experiments which demonstrated that classification, combined with re-crushing, was the most economical method of obtaining both the greatest crushing duty and high extraction. 2300 w. Eng & Min Jour—March 2, 1905. No. 68137.

Ore Washing.

Ore Washing in Cripple Creek, Colo. Illustrates and describes the practice at the different mines. 2000 w. Min & Sci Pr—Feb. 18, 1905. No. 68079.

Quebec.

The Bed-Rock of the Gilbert River Goldfields, Quebec. John A. Dresser. Read before the Canadian Min. Inst. A brief study of the gold-bearing rocks of this region. 1000 w. Eng & Min Jour—March 23, 1905. No. 68592.

Queensland.

Scottish Gympic Gold Mines. R. Logan Jack. Report on the geology, mining, &c. 5000 w. Queens Gov Min Jour—Jan. 14, 1905. No. 68206 B.

Slimes.

Fluxing of Gold Slimes. Charles E. Meyer. Explains the theory and calculation of flux, giving results. 1200 w. Jour Chem, Met, & Min Soc of S Africa—Jan., 1905. No. 68518 E.

South Africa.

Notes on the Occurrence of Gold in Primary Formations. E. F. Heneage and W. G. Holford. An account of experience during prospecting work in mineralized zones of the older sedimentary formations of South Africa. 3500 w. Jour S Af Assn of Engrs—Nov., 1904. No. 68129 F.

Veins.

Characteristics of Gold-Quartz Veins in Victoria. Waldemar Lindgren. Describes these veins and discusses the theories advanced to explain their formation. 2500 w. Eng & Min Jour—March 9, 1905. No. 68244.

Victoria.

Marine Tertiary Rocks of Victoria. E. J. Alexander. A lecture on the relationship of the auriferous gravels and drifts of Victoria to the marine tertiary rocks. 3000 w. Aust Min Stand—Feb. 2, 1905. No. 68298 B.

Yukon.

Yukon Territory. From the recently issued annual report of the Department of the Interior, giving information of mining, assaying, and related matters. Ills. 4500 w. B C Min Rec—March, 1905. No. 68683 B.

IRON AND STEEL.

Blast-Furnaces.

Blast-Furnace Plant of the "Elba" Società Anonima di Miniere e di Alti Forni at Portoferraio, Elba. Carlo Massa. Illustrated detailed description of the plant. 2800 w. Am Inst of Min Engrs—March, 1905. No. 68566.

Notes on the Evolution of Blast Furnace Recovery Plant. J. Gillespie. Presents some of the steps in the evolution of the blast furnace recovery plant, describing details. Ills. 6500 w. Jour of W of Scot Ir & Steel Inst—Jan., 1905. No. 68689 F.

Briquetting.

Briquetting Plant for Iron Ore (Erzbrikettierungsanlage). H. Zeidler. A detailed description of the plant of the iron works at Kertsch, in Southern Russia. 3500 w. Stahl u Eisen—March 15, 1905. No. 68442 D.

Cast Iron.

See Mechanical Engineering, Materials.

Charging Machines.

Machines for Charging Ingots and Scrap into Open-Hearth Furnaces (Machines à Charger les Lingots et les Riblons dans les Fours à Réchauffer). Describing electric and steam charging machines of recent German design. 1800 w. 1 plate. Génie Civil—Feb. 11, 1905. No. 68411 D.

Cold Blast.

The Use of Cold-Blast Iron for Making Low Steel (Verwendung von Kalt Erblasenen Roheisen zur Flusseisendarstellung). Dr. Geilenkirchen. An examination of the relative suitability of hot and cold blast iron for use in the open-hearth steel process. Serial. Part I. 4000 w. Stahl u Eisen—March 15, 1905. No. 68443 D.

Dry Air Blast.

Dry Blast and Turbo-Blowers (Windtrocknung und Turbogebläse). Prof. W. Mathesius. A study of the removal of moisture from air blast by the use of chemical absorbents. 1800 w. Stahl u Eisen—March 1, 1905. No. 68440 D.

Dry-Air Blast for Blast Furnaces (La Dessication de l'Air dans le Soufflage des Hauts-Fourneaux). G. Chesneau. A review of the criticisms of the Gayley process, urging caution in repeating the ex-

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periment. 1200 w. L'Electrochimie—Jan., 1905. No. 68488 D.

The Use of Dried Air in the Blast Furnace. A. Pourcel, in the *Revue de Metallurgie.* A discussion of the Gayley dry blast. 1800 w. Ir & Coal Trds Rev—March 3, 1905. No. 68318 A.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Gas Valves.

Double Gas Valves (Ueber Doppelte Gichtverschlusse). K. Stähler. Describing especially the Buderus double-cone valve for blast furnaces, enabling the gas to be drawn off continuously without interfering with the charging of the furnace. 1800 w. Stahl u Eisen—Feb. 15, 1905. No. 68436 D.

Henry Cort.

The Case of Henry Cort. Charles H. Morgan. On the nature of his inventions, their value to England and to mankind, the meagre remuneration received by him and his family, and the suitable permanent record and recognition of his services. 3300 w. Ills. Am Inst of Min Engrs—March, 1905. No. 68564.

Open-Hearth.

Open-Hearth Furnaces. G. L. Luetscher. An illustrated description of the open-hearth furnace. General discussion. 6000 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68571 D.

Pig Iron.

A New Process for Refining Pig Iron. J. B. Nau. Describes a method devised with the aim of applying it to the preliminary and partial refining of pig iron too high in silicon and phosphorus to be treated economically in the open hearth furnace. Treats of refining pig iron by means of iron ores. 3800 w. Ir Age—March 23, 1905. Serial. 1st part. No. 68555.

See Mechanical Engineering, Materials.

Rolling Mills.

Armor-Plate Rolling Mill for the French Government (Panzerplattenwalzwerk der Französischen Marineverwaltung). W. Schnell. Illustrating heavy reversing rolling mill built in Germany for the *Forges Nationale de la Chaussade* at Guérigny, France. 1000 w. 1 plate. Stahl u Eisen—Feb. 15, 1905. No. 68435 D.

Plans for Modernizing Antiquated Rolling Mills (Vorschläge zur Modernisierung Veralteter Walzwerksanlagen). Adolf Röck. A review of a previous paper by Hübers, comparing the efficiency of old and new methods and appliances. 2000 w. Stahl u Eisen—March 1, 1905. No. 68439 D.

Steel.

See Mechanical Engineering, Materials.

Steel Metallurgy.

Abstract of Lecture by Professor J. O. Arnold, University College, Sheffield, on "The Relation of Theory to Practice in Steel Metallurgy." Also discussion. 6500 w. Jour W of Scot Ir & Steel Inst—Jan., 1905. No. 68690 F.

Steel Works.

The Illinois Steel Company's Additions. Illustrated description of the new open hearth steel works and blooming and structural mills and their equipment. 1500 w. Ir Age—March 2, 1905. No. 68086.

Tube-Mills.

Tube-Mill Notes. Alfred James. Abstracted from contribution to discussion, Inst. of Min. & Met. Comments on practice and results. 800 w. Eng & Min Jour—March 16, 1905. No. 68363.

Utah.

Iron Ores in Utah. Don Maguire. Concerning the location and extent of a number of deposits which may prove of great value to the State. Ills. 1800 w. Mines & Min—March, 1905. No. 68235 C.

MINING.

Alaska.

Traveling in Alaska. J. P. Hutchins. An illustrated account, giving much information of interest to miners who have occasion to visit this region. 2000 w. Eng & Min Jour—March 16, 1905. No. 68361.

Analysis.

Grading Analyses. H. S. Denny. Abstract of a paper read before the S. African Assn. of Engrs. Explains the meaning of the term and its objects, considering methods and their results. 1700 w. Eng & Min Jour—March 9, 1905. No. 68246.

Concentration.

Concentrating Tables. Charles W. Comstock. With a discussion of the principles of concentration and their application in practice. 4000 w. Mines & Min—March, 1905. No. 68234 C.

Separating and Concentrating Complex Ores. Robert T. Clegg. Briefly reviews methods of concentration practiced, and describes the Simplex system of ore dressing, invented by Eric Hedburg. 1500 w. Min Wld—March 11, 1905. No. 68293.

Development.

The Choice of a System of Development for a Mining Property (Die Wahl eines Ausrichtungssystems beim Abbaue

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einer Flözgrubbe). B. Boky. A discussion of the conditions governing the choice of the method of working a mining district, with especial reference to Russian coal workings. Serial. Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 25, 1905. No. 68695 D.

Electric Power.

Application of Electricity to Mines. A. C. Anderson. Read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Remarks on the increased use of electricity in mines and its advantages, the choice of a system, voltage, generating plant, distribution, &c. 3300 w. Elec Engr, Lond—March 3, 1905. Serial. 1st part. No. 68302 A.

Special Rules for the Installation and Use of Electricity in Mines. Gives rules prepared by the Home Secretary. 4400 w. Elect'n, Lond—Feb. 24, 1905. No. 68219 A.

Tests of the Electric Light and Power Plant of the Dalbusch Mine (Untersuchung der Elektrischen Kraft und Lichtcentrale auf Zeche Dalbusch). A general description of the plant, and details of the tests of the turbo-alternator, and distribution. Two articles. 6000 w. Glückauf—Feb. 25, March 4, 1905. No. 68499 each B.

Gas Producers.

See Mech. Engng., Combustion Motors.

Hoisting.

An Underground Skip-hoisting Plant. S. A. Worcester. Brief illustrated description of plant for the Camp Bird gold mine for hoisting ore and waste from a depth of 900 ft. 500 w. Eng & Min Jour—March 2, 1905. No. 68134.

Electric Winding Engines. Aims to show that electrical winding eliminates a large source of loss. 3300 w. Prac Engr—March 17, 1905. Serial. 1st part. No. 68640 A.

Pumping.

Pumping on the Comstock. Carl George P. de Laval. Describes the installation of modern pumps to overcome the difficulties at the Comstock. Ills. 2300 w. Eng & Min Jour—March 16, 1905. No. 68367.

Roasting.

Furnaces for Blende and Pyrites Roasting. Walter Renton Ingalls. Describes furnaces used by American zinc smelters, and especially the McDougall type of furnaces for roasting pyrites, pyrrotite and chalcopyrite. 3800 w. Min Wld—March 4, 1905. No. 68199.

Shaft Lining.

The Question of Corrugated Tubbings (Zur Frage der Gewellten Tubbings). Prof. Heise. Practical data concerning the lining of shafts with metallic corrugated tubbings, showing the capacity of the system to resist pressure. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 4, 1905. No. 68696 D.

The Question of Shaft Tubbings and Methods of Strengthening Them (Zur Frage der Schachttubbings und deren Verstärkung), H. Hoffmann. An examination of the stresses upon the linings of shafts, with arrangements for reinforcement by means of ribs and clamps. 1200 w. Glückauf—March 4, 1905. No. 68692 B.

The Strength of Corrugated and Other Forms of Tubbings (Neues über die Festigkeitsverhältnisse Gewellter und anderer Tubbings). Prof. Heise. A theoretical investigation to determine the strongest form of shaft lining. 2000 w. Glückauf—March 4, 1905. No. 68693 B.

Superintending.

Mine Superintending. E. Rammelmeyer. On the duties and responsibilities of the man who directs the work in and about a mine. 1500 w. Min & Sci Pr—March 4, 1905. No. 68291.

Timbering.

Timbering at the Chillagoe Mines. T. J. Greenway. Illustrates and describes a method adopted in Queensland which permitted the use of local timber without the aid of a saw-mill. 500 w. Eng & Min Jour—March 16, 1905. No. 68365.

Veins.

Vein Structure. O. H. Howarth. Observations in regard to the manner of vein formation and the forces causing them. Ills. 3000 w. Mines & Min—March, 1905. No. 68226 C.

Ventilation.

The Ventilation of Mines. Abstracted from Appendix II. Inspection of Coal Mines Report (New Zealand), 1904. Gives formulas developed and explains their application. 1800 w. Col Guard (Sup.)—March 17, 1905. No. 68654 A.

MISCELLANY.

Antimony.

The Occurrence of Stibnite at Steamboat Springs, Nevada. Waldemar Lindgren. Believes that stibnite and pyrite were deposited by the hot waters which permeate the gravel. 1200 w. Am Inst of Min Engrs—March, 1905. No. 68562.

Emery.

Emery, Its Occurrence, Uses, &c. Herman Shultz. Notes on the scarcity of crude emery ore, the location of the deposits, the imports into the United States,

its uses, &c. 1000 w. Min Wld—Feb. 25, 1905. No. 68075.

Gypsum.

Montana Gypsum Deposits. Jesse Perry Rowe. An illustrated description of these extensive deposits and their geological formations. 2700 w. Am Geol—Feb., 1905. No. 68297 D.

Quicksilver.

The Quicksilver Deposits of Huitzuco. Frank D. Pagliucci. Illustrates and describes these deposits in Mexico and their development. 600 w. Eng & Min Jour—March 2, 1905. No. 68136.

Tin.

The Assaying of Tin and Terne Drosses. George P. Maury. Brief description of the preparation of the samples, the assay, and the analysis of the button from the assay. 1300 w. Pro Engrs' Soc of W Penn—March, 1905. No. 68570 D.

The Mount Bischoff Tin Mine. Sydney Fawns. An account of this mine in Tasmania, 3,500 ft. above sea level, the method of mining, &c. 1400 w. Eng & Min Jour—March 9, 1905. No. 68247.

Zinc.

Character of American Zinc Ores and Industry. Walter Renton Ingalls. Gives a review of the smelting practice at the various mines, describing the character of the ore. 2700 w. Min Wld—Feb. 25, 1905. No. 68074.

Notes on the Metallurgy of Zinc (Beiträge zur Metallurgie des Zinks). A discussion of methods of treating various zinc ores. Serial. Part I. 1500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 11, 1905. No. 68697 D.

Roasting and Magnetic Separation of a Blende-Marcasite Concentrate. H. O. Hofman and H. L. Norton. Describes the ore, giving an outline of the experimental work, describing apparatus and methods of analysis, results of experiments, and conclusion. 4500 w. Am Inst of Min Engrs—March, 1905. No. 68565 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Derailment.

The Derailment on the Great Western Railway. A report of the Board of Trade inquiry into an accident on Oct. 4th last in Wales. 4800 w. Engr, Lond—Feb. 17, 1905. No. 68059 A.

Disaster.

The Slanelly Disaster. Editorial on Col. Yorke's report of this accident which occurred in Oct., 1904, discussing the cause. 1200 w. Engng—Feb. 24, 1905. No. 68221 A.

English Railroads.

Why English Railroads Are Safe. James Davenport Whelpley. Discusses the safeguards employed, government supervision, and the pressure of public opinion. Ills. 3700 w. World's Work—March, 1905. No. 68163 C.

Rules.

Standard-Code Rules. H. W. Forman. Discusses the need of revision of rules for single track. 3000 w. R R Gaz—Vol. XXXVIII., No. 9. Serial. 1st part. No. 68146.

MOTIVE POWER AND EQUIPMENT.

Cars.

Flat Cars for the Argentine Government Railways. Illustrates and describes the principal features of their construction. 1500 w. R R Gaz—Vol. XXXVIII., No. 9. No. 68145.

Coal Economy.

Saving Coal on Locomotives. A Sailor. Discusses how to reduce the quantity of coal burnt for the same service, giving methods used in France, and the steps taken to induce men to use it carefully. 2500 w. Ry Age—March 17, 1905. No. 68388.

Loaders.

Box-Car Loaders. William L. Affelder. Illustrated description of some of the early types and their development to those in use at the present time. 6000 w. Mines & Min—March, 1905. No. 68227 C.

Locomotive Practice.

Locomotive Practice on the New Zealand Government Railways. Charles Rous-Marten. Describes interesting features of the railway history, the conditions to be met, the early construction, types of locomotives used, their work, &c. Ills. 5700 w. Cassier's Mag—March, 1905. No. 68126 B.

Locomotives.

Chicago, Milwaukee, & St. Paul Pacific Locomotive. Illustrated description of a powerful passenger engine, with principal dimensions. 600 w. Ry Age—March 17, 1905. No. 68389.

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Double End Narrow Gauge Tank Locomotive for Japan. Illustrated description with principal dimensions. 500 w. Ry Age—March 10, 1905. No. 68256.

Double Ender Tank Locomotive. Illustrates and describes a 2-6-2 engine built for the Chicago & Western Indiana. 500 w. Ry & Loc Engng—March, 1905. No. 68157 C.

High-Speed Compound Locomotives (Locomotives Compound à Grande Vitesse). Ch. Baudry. Illustrated description of four-cylinder compound express locomotives for the Paris-Lyons-Mediterranean system, with complete specifications and drawings. 3500 w. 3 plates. Rev Gen d Chem de Fer—Feb., 1905. No. 68432 G.

Locomotives for Japan. Illustrates and describes a type of narrow gauge tank engine for which an order for sixty-eight has been given by Japan to an English firm. 600 w. Engr, Lond—March 10, 1905. No. 68546 A.

Powerful "Rack and Adhesion" Locomotives for the Central South African Railway. Illustrated description of an engine for exceptionally severe gradients. 1000 w. Prac Engr—March 17, 1905. No. 68641 A.

Prairie Type Freight and Passenger Locomotives. Brief illustrated description of engines of the 2-6-2 type for the C., B. & Q. Ry. 600 w. Am Engr & R R Jour—March, 1905. No. 68132 C.

Six-Coupled Tank Locomotive for the Furness Railway. Illustrations, principal dimensions, and brief description. 600 w. Engng—March 3, 1905. No. 68310 A.

Southern Railway Six-Wheel Switching Engines. Illustration, and views and cross section with brief description. 300 w. Ry Age—March 3, 1905. No. 68200.

The Compounding of Locomotive Engines. John Riekie. Briefly considers the various types and the systems of working. 2000 w. Trans Inst of Engrs & Shipbuilders of Scot—Feb. 21, 1905. No. 68688 D.

Locomotive Testing.

Locomotive Testing Plant of the Pennsylvania at St. Louis. An illustrated detailed description. 2000 w. R R Gaz—Vol. XXXVIII., No. 10. No. 68270.

Motor-Car.

Steam-Motor Carriage for the Shappey Light Railway; S.-E. and C. R. Company. Brief illustrated description. 500 w. Engng—March 3, 1905. No. 68309 A.

Oscillations.

The Oscillations of Railway Vehicles upon their Springs (Oscillation des Véhicules de Chemin de Fer sur leurs Ressorts de Suspension). Georges Marié. Showing the importance of a rigid roadbed and great flexibility of springs, in diminishing oscillations. 1200 w. Comptes Rendus—March 6, 1905. No. 68450 D.

Train Lighting.

McElroy Automatic Axle Lighting System. Illustrates and describes this system of electric train lighting. 900 w. Ry Age—March 3, 1905. No. 68201.

The Electric Lighting of Trains (L'Eclairage Electrique des Trains). An illustrated description of the Aichele system, employing a dynamo driven from the car axle. 3500 w. Bull Tech de la Suisse Romande—Jan. 25, 1905. No. 68716 D.

The Leitner-Lucas System of Electric Train Lighting. An illustrated description of a system applied to independent single railway coaches, which is under trial in England. 1800 w. Elec Rev, Lond—March 17, 1905. Serial. 1st part. No. 68649 A.

Valves.

The High and Low Pressure Retaining Valve. Illustrated description of a device for increasing the certainty of controlling heavily loaded trains. 1200 w. R R Gaz—Vol. XXXVIII., No. 12. No. 68596.

Wheels.

The Life of Wheels and Rails. George E. Walsh. Remarks on the factors that affect the life of both wheels and rails, the types, construction, &c. 1800 w. Ry Age—March 24, 1905. No. 68674.

NEW PROJECTS.

Canada.

The Canadian Northern Railway in the West. R. D. Willson. An illustrated article, with map, describing construction work and great increase in mileage. 2000 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68376.

Extension.

The Cumberland Extension of the Western Maryland R. R. Illustrated detailed description of construction work under many difficulties, from Big Pool to Cumberland. 3500 w. Eng Rec—March 4, 1905. Serial. 1st part. No. 68181.

Western Railroad Extensions and Mining. Gives map, indicating the completed and projected transcontinental lines in the United States, Canada, and Mexico, discussing their influence on mining in the important mineral districts which they traverse. 1700 w. Min Wld—March 11, 1905. No. 68292.

Improvements.

Improvements on the Cleveland Di-

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vision of the B. & O. Illustrated description of improvements to cost about $4,000,000, including straightening the line, reducing grades and changing from single to double tracks. 2200 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68369.

Improvements on the New York, New Haven & Hartford. Map, plans and description of proposed changes on this very important road, including the rebuilding of the Harlem & Port Chester as a six-track line, wholly or partially operated by electricity. 3500 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68374.

Location.

Mathematics of the Paper Location of a Railroad. J. C. L. Fish. Presents the mathematical steps involved in preparing, from the paper location of a railroad, a set of mathematically consistent alignment notes by which to run the corresponding field location. 3500 w. Eng News—March 16, 1905. No. 68336.

New Line.

The Denver, Northwestern and Pacific Ry. W. P. Hardesty. An illustrated detailed description of the construction of a new line which shortens the distance by rail between Denver and Salt Lake City, and opens new territory. 4500 w. Eng News—March 9, 1905. No. 68271.

The Denver, Northwestern & Pacific Road. Illustrated description of a line between Denver, Colo., and Salt Lake, Utah, recently completed as far as Arrowhead. 2200 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68372.

Reconstruction.

Rebuilding the O. R. & N. A fully illustrated article of work on the Oregon Railroad & Navigation lines to make a route of low grades and easy curves. 800 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68371.

Simplon.

The Northern Lines of Access to the Simplon (Per gli Accessi Nord al Sempione). N. Sacerdoti. A discussion of the railway connections on the Swiss side of the Simplon tunnel, including the Lotschberg, Stockalper, and Wildstrubel routes. 4000 w. Il Monitore Tecnico—Jan. 20, 1905. No. 68709 D.

PERMANENT WAYS AND BUILDINGS.

Line Improvements.

Line Improvements Between Indianapolis and Cincinnati, C. C. C. & St. L. R. R. George A. Stearns. Describes briefly work including reducing grades, straightening the line, replacing bridges, and double tracking, without interrupting traffic. Ills. 800 w. Eng News—March 16, 1905. No. 68337.

Metal Structures.

Iron and Steel Structures. Abstract of report presented at meeting of the Am. Main. of Way Assn. General specifications, with discussion. 22500 w. Ry Age—March 24, 1905. No. 68679.

Narrow Gauge.

Narrow - Gauge Railways (Ueber Schmalspurbahnen). H. Schwabe. An examination of the relative construction and operation costs of standard and narrow-gauge railways, with especial reference to lines in the German African colonies. 3500 w. Glasers Annalen—March 15, 1905. No. 68456 D.

Rail Wear.

The Wave-Like Wear of Rail Heads (Ueber die Wellenförmige Abnutzungerscheinung am Kopfe der Schienen). R. Scheibe. With photographs showing the nature of the wear on the rail; suggesting that the action may be due to unequal hardness caused in the rolling process. 1200 w. Glasers Annalen—March 1, 1905. No. 68453 D.

Reports.

American Railway Engineering and Maintenance of Way Association Reports. Abstracts of the reports presented to the Maintenance of Way Assn., covering a wide range of subjects. 13500 w. R R Gaz—Vol. XXXVIII., No. 12. No. 68595.

Committee Reports of the American Railway Engineering and Maintenance of Way Association. Abstracts of reports on ballasting, ties, buildings, masonry, yards and terminals, &c. 6500 w. Eng News—March 23, 1905. No. 68588.

Roadway.

Roadway. Abstract of Report at meeting of the Am. Main. of Way Assn. Gives specifications for the formation of roadbed, standard plans, &c., with discussion. 7500 w. Ry Age—March 24, 1905. No. 68678.

Shops.

Locomotive Repair Shops of the Père Marquette. Illustrated detailed description of the shops at Grand Rapids, Mich., and their equipment. 5500 w. Ry Age—March 24, 1905. No. 68676.

Running Railroad Repair Shops on the Monthly Appropriation Plan. Charles Streicher. Showing the advantages of this method. General discussion. 10000 w. Pro N Y R R Club—Feb. 17, 1905. No. 68342.

The Kingsland Shops of the Delaware, Lackawanna & Western R. R. Brief il-

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lustrated description of shops in course of construction at Kingsland, N. J. 800 w. Eng Rec—March 25, 1905. No. 68631.

Signalling.

Auxiliary Railway Signalling. Remarks on the most generally approved systems of auxiliary signalling, considering briefly some of their chief characteristics. 3700 w. Elec Engr, Lond—Feb. 24, 1903. No. 68212 A.

Improvements in Railway Safety Appliances (Neuerungen im Eisenbahnsicherungswesen). H. Scholkmann. Describing improved block signal systems, including electric, pneumatic, and liquefied gas control and operation. 5000 w. 1 plate. Glasers Annalen—Feb. 15, 1905. No. 68463 D.

Signaling and Interlocking. Abstract of report at meeting of Am. Main. of Way Assn. Considers the standard arrangement of signals, controlling, construction, &c, with discussion. 10500 w. Ry Age—March 24, 1905. No. 68680.

Standard Arrangement of Signals at Interlocking Plants. From a report of a Committee of the American Railway Engineering and Maintenance of Way Association. 2000 w. Eng News—March 23, 1905. No. 68589.

Supplying Electric Current for Interlocking Plants. C. C. Anthony. Describes a method of supplying current to interlocking switches and signals. 1800 w. R R Gaz—Vol. XXXVIII. No. 11. No. 68378.

Standardizing.

A Method for Standardizing Maintenance of Way Forces. H. W. Church. Gives statistics for summer and winter work and explains method by example and chart. 2000 w. Ry & Engng Rev—March 18, 1905. No. 68504.

Subsidence.

Coal Workings Under a Railway. Clement E. Stretton. Read before the Leicester Sec. of the Permanent Way Inst. Briefly considers the practical and the legal side of subsidence caused by mining in England. 1500 w. Col Guard—March 10, 1905. No. 68530 A.

Switzerland.

The New Lines of the Rhaeticon Railway (Les Nouvelles Lignes du Chemin de Fer Rhétique). F. Rey. Illustrating especially the Albula line from Thusis to St. Moritz, with topographical maps, profiles, and illustrations. 8000 w. Rev Gen d Chem de Fer—Feb., 1905. No. 68433 G.

Terminals.

New D. L. & W. Terminal at Hoboken. Illustrations and brief description of proposed new railroad and ferry terminal. 500 w. R R Gaz—Vol XXXVIII. No. 12. No. 68593.

New Terminal at Washington, D. C. An illustrated detailed description of the union station, the station grounds, and yard tracks, the methods of construction, &c, with a full account of the work thus far. 7400 w. Ry & Engng Rev—March 18, 1905. No. 68506.

Recent Terminal Improvements. Daniel Breck. Gives an outline of the work undertaken at the Union Station of St. Louis, during the Exposition. 7300 w. St Louis Ry Club—Feb. 10, 1905. No. 68084.

The Pennsylvania Freight Terminals in New York. An illustrated description of new arrangements for handling the enormous freight business of New York and vicinity. 3500 w. R R Gaz—Vol. XXXVIII., No. 11. No. 68373.

Ties.

Rail Circuits and Zinc-Treated Ties. Extract from report of V. I. Smart, giving details of an interesting phenomenon caused by treating ties with zinc-chloride preservative. 600 w. R R Gaz—Vol. XXXVIII. No. 12. No. 68594.

Tracks.

Double-Track Work on the Southern Railway Between Alexandria and Orange, Va. John W. Ash. An illustrated description of the work of grading, track work, bridges and masonry. 3500 w. Eng News—March 2, 1905. No. 68109.

Track Elevation and Depression at Milwaukee. Brief illustrated account of work completed and projected. 1200 w. Eng News—March 9, 1905. No. 68282.

Track Elevation of the Chicago & Western Indiana Through the City of Chicago. An illustrated article describing the equipment, method of operation, materials, &c. 2800 w. Ry Age—March 24, 1905. No. 68671.

Trestle Timber.

Wooden Bridges and Trestles. Abstract of report presented at meeting of the Am. Main. of Way Assn. Gives specifications compiled for bridge timber, and for trestles; also paper by A. F. Robinson on "Standard Plans for Pile and Timber Trestle Bridges, Santa Fé Railway System," with discussion. Ills. 17000 w. Ry Age—March 24, 1905. No. 68677.

Yards.

The Greenville Yards and Transfer Arrangements of the Pennsylvania Railroad. Illustrated detailed description of important developments at this point, preparatory to caring for the expected increase in traffic, which includes New Eng-

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land business in connection with the N. Y., N. H. & H. R. R. 2000 w. Ry Age—March 24, 1905. No. 68673.

Yards and Terminals. Abstract of a report at meeting of the Main. of Way Assn. Considers especially summit and gravity yards. Short discussion. 4500 w. Ry Age—March 24, 1905. No. 68681.

TRAFFIC.

Automobiles.

Report on the Question of Traffic Conveyed by Automobiles (Subject XX for Discussion at the Seventh Session of the Railway Congress). Messrs. Keromnes, Léchelle, and E. Sartiaux. 11200 w. Ills. 1 table. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68620 F.

Cheap Service.

On the Question of the Organization of a Cheap Service on a Main Railway's Branch Lines which Carry Little Traffic and on Light Railways. Cornel de Tolnay. Subject XIV for discussion at the seventh session of the railway congress. For Austria-Hungary, Germany, and Holland. 5700 w. Ills. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68618 E.

India.

Goods Traffic on Indian Railways. Information concerning the unsatisfactory speed of India goods trains, discussing some of the causes. 1500 w. Engr, Lond—March 17, 1905. No. 68664 A.

Light Railways.

Report on the Question of the Influence of Light Railways on the Main Lines (Subject XVII for Discussion at the Seventh Session of the Railway Congress. Mr. De Burlet. 10900 w. 16 tables. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68451 G.

Pooling Locomotives.

On the Question of Pooling Locomotives (Subject VI for Discussion at the Seventh Session of the Railway Congress). E. Hubert. Report (No. 3) for Belgium, England and colonies, Holland, Denmark, Russia, Sweden and Norway. 7000 w. 1 table. Bul Int. Ry Cong—Feb., 1905. No. 68384 E.

Statistics.

Statistics of International Transport (Statistique des Transports Internationaux). Gen. A. de Wenderich. Giving forms and procedure employed for recording locomotive performance. 2000 w. Rev Gen d Chem de Fer—March, 1905. No. 68451 G.

STREET AND ELECTRIC RAILWAYS

Cable Incline.

Rebuilding of the Lauterbrunnen Grütschalp Cable Incline (Umbau der Seilbahn Lauterbrunnen Grütschalp). Siegfried Abt. The road has a grade of 55.47 per cent., with a difference of level of 670 metres between terminals. 2000 w. Schweiz Bauzeitung—March 4, 1905. No. 68497 B.

Car Equipment.

Car Lighting and Ventilation. John P. Fox. Illustrates and describes some of the methods employed on foreign roads. 800 w. St Ry Jour—March 25, 1905. No. 68624 C.

The Electrical Equipment of the New Steel Cars for the New York Subway. L. B. Stillwell. Illustrates and describes an important development in methods of wiring for electric cars. 5400 w. St Ry Jour—March 4, 1905. No. 68176 C.

Cars.

Steel Passenger Cars on the Metropolitan Elevated Ry., Chicago. Illustrated description of cars of nearly all-steel construction. The only wood used is for interior finish. 500 w. Ry & Engng Rev—March 4, 1905. No. 68165.

Car Wheels.

Car Wheels—A Study of Their Costs. D. F. Carver. Gives diagrams for determining service and scrap value of new and worn cast-iron wheels, and for comparing cost of iron and steel wheels and steel tires, and method of reasoning by which conclusions are reached. 2300 w. St Ry Jour—March 11, 1905. No. 68262 C.

Chicago Elevated.

Methods of Increasing the Capacity and Reducing the Noise Upon the Union Elevated Railroad of Chicago. Abstract of the second report of Bion J. Arnold. Ills. 3600 w. St Ry Rev—March 15, 1905. No. 68615 C.

Report upon Increasing the Capacity and Reducing the Noise of the Union Elevated Railroad of Chicago. A report on these two subjects by Bion J. Arnold is given in extract. Ills. 7300 w. St Ry Jour—March 18, 1905. No. 68393 C.

We supply copies of these articles. See page 319.

Construction.

Tramways Permanent-Way Construction and Maintenance. James Lord. Abstract of a paper read before the Leeds Loc. Sec. of the Inst. of Elec. Engrs. Describes methods used by the writer, illustrating apparatus. 2400 w. Elect'n, Lond —March 10, 1905. No. 68551 A.

Dynamometer Car.

An Air-Resistance Dynamometer Car. Illustrated description of the air-resistance test car "Louisiana," constructed for the use of the Electric Railway Test Commission of the Louisiana Purchase Exposition. 1700 w. Eng News—March 23, 1905. No. 68583.

Electric Traction.

On the Question of Electric Traction (Subject VIII for Discussion at the Seventh Session of the Railway Congress). W. D. Young. Report (No. 3) for America. 4400 w. 3 tables & figs. Bul Int Ry Cong—Feb., 1905. No. 68383 E.

On the Question of Electric Traction (Subject VIII for Discussion at the Seventh Session of the Railway Congress). Ernest Gerard. Report No. 2 for Great Britain and Ireland, and Belgium. 2600 w. 7 tables & Ills. Bul Int Ry Cong (2d part)—Feb., 1905. No. 68622 E.

High Pressure.

High-Pressure Line Construction for Alternating-Current Railways. Theodore Varney. Illustrates and describes some preliminary work which has been carried out on a practical scale with overhead conductors. 2200 w. Am Inst of Elec Engrs—March, 1905. No. 68558 C.

Line Construction for High Pressure Electric Railroads. George A. Damon. Gives a brief record of what has been accomplished in line construction, and examines the requirements and difficulties of installation in order to obtain permanent insulation at reasonable cost. Ills. 3500 w. Am Inst of Elec Engrs—March, 1905. No. 68557 C.

Illinois.

McKinley Syndicate Properties of Northern Illinois. Illustrated description of the interurban line of the Illinois Valley Ry. from Ladd, Ill., to Marseilles. 2500 w. St Ry Rev—March 15, 1905. Serial. 1st part. No. 68612 C.

Interurban.

The Gerardmer-Retournemer-Honeck Tramway (Tramway de Gerardmer à Retournemer-La Schlucht-Le Honeck). A. Moutier. Description of construction material, and operation of an interurban steam railway in the Vosges near Belfort. 4000 w. 2 plates. Rev Gen d Chem de Fer—Jan., 1905. No. 68430 G.

London.

The Waterloo and City Railway.—Working Results. Herbert Jones. Abstract of a paper read before the Tram. & Lgt. Rys. Assn. Briefly describes the construction and equipment of the line, its operation, and reports 24-hour tests being made. 2800 w. Elect'n, Lond—Feb. 24, 1905. Serial. 1st part. No. 68218 A.

Waterloo and City Railway. Herbert Jones. Read before the Tram. & Lgt. Rys. Assn., London. A brief description of the plant and its equipment and the working results. 4500 w. Tram & Ry Wld—March 9, 1905. No. 68529 B.

London Underground.

The Electrification of the London Underground Electric Railways Company's System. S. B. Fortenbaugh. A full illustrated detailed description of this very interesting installation. 13500 w. St Ry Jour—March 4, 1905. No. 68175 C.

New Car.

New 4000-Type Car for Buffalo. Illustrated detailed description of new cars placed in service between Buffalo, Niagara Falls, and Lockport. 1500 w. St Ry Jour —March 25, 1905. No. 68625 C.

Paris.

The Paris Metropolitan Railway. An illustrated description of the construction of the Pasay bridge and viaduct. 2000 w. Engr, Lond—March 10, 1905. No. 68545 A.

Pavements.

Laying Street Railway Tracks in Cincinnati: Specifications for Bitulithic Pavement. J. M. Harper. Abstract of a paper read before the Ohio Eng'ng Soc. Gives a brief description of the concrete construction of a double-track railway on one of the principal crosstown lines. 2500 w. Eng News—March 2, 1905. No. 68119.

Power Houses.

See Electrical Engineering, Generating Stations.

Protective Devices.

Fuses versus Circuit Breakers for Protection of Railway Apparatus. Edward Taylor. Describes the construction of each device stating the advantages, and concludes that only by the use of both devices, conjointly, is it possible to properly protect a railway motor. 5600 w. St Ry Jour—March 25, 1905. No. 68626 C.

Railway Motors.

See Electrical Engineering, Motors.

Single-Phase.

Murnau Ober-Ammergau Single-Phase

We supply copies of these articles. See page 319.

Railway. Illustrates and describes this line which traverses a mountainous region, and has some interesting points of novelty. 1000 w. Elec Rev, Lond—March 17, 1905. No. 68651 A.

Single-Phase Car Equipment of the Indianapolis & Cincinnati Traction Company. Brief illustrated description. 1200 w. St Ry Rev—March 15, 1905. No. 68614 C.

Stray Currents.

Report on Electrolysis. E. F. Scattergood. Showing comparative effect of lead and cement joints in city water mains. 600 w. Sib Jour of Engng—March, 1905. No. 68380 C.

The Electrolytic Corrosion of Underground Metallic Pipes (Corrosions Electrolytiques des Canalisations Métalliques Souterraines). M. Nourtier. A review of the conditions under which gas, water, and other pipes are attacked by stray currents from electric tramways. 2500 w. Rev Technique—Feb. 25, 1905. No. 68429 D.

Subway.

The New York Subway (Die New Yorker Untergrundbahn). Franz Köster. A fully illustrated account of the subway, power house and rolling stock of the New York Rapid Transit Company. Serial. Part I. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—March 4, 1905. No. 68406 D.

Testing.

Recent Work of the Electric Railway Test Commission. Especially describing the work of the dynamometer car designed and constructed for the purpose of measuring directly the head and rear pressures and the side and roof resistances of car bodies. Ills. 1600 w. St Ry Jour—March 25, 1905. No. 68623 C.

Tracks.

On Track Bonding. C. W. Ricker. Considers in detail the various kinds of bonding, and the conditions governing the material form and structure of bonds; the importance of good contacts, &c. 4400 w. Am Inst of Elec Engrs—March, 1905. No. 68559.

Track Laying on the Williamsburg Bridge. Illustrated description of methods used in laying tracks for two lines of elevated railroad, and two lines of electric street cars, aggregating about five miles in length. 2400 w. Eng Rec—March 4, 1905. No. 68190.

Tyrol.

The Stubai Valley Railway (Die Stubaitalbahn). Illustrated account of a single-phase electric railway between Innsbruck and Fulpmes, in the Tyrol, with data as to operating costs. 2000 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68468 B.

Voltage.

Feeder and Rail Drop. J. W. Welsh. Gives a method found convenient for the calculation of simple lay-outs where the number of circuits are few. Illustrates the method in a case where several feeders supply direct-current to an interurban electric road. 800 w. Elec Club Jour—March, 1905. No. 68509.

Valtellina.

Measurements on the Valtellina Railway (Messungen auf der Valtellina Bahn). M. Novi & A. Donati. Results of measurements, showing a consumption of energy of 48 watt-hours per ton-kilometer. On down grades more than 50 per cent. of the energy of the train can be returned to the line. 2000 w. Elektrotech Zeitschr—Feb. 16, 1905. No. 68469 B.

The New Electric Locomotives of the Valtellina Railway (Die Neuen Elektrischen Lokomotiven der Valtellina-Bahn). Eugen Cserhati. Full detailed description of the improved three-phase electric locomotives built by Ganz for the Valtellina line in Northern Italy. Serial. Part I. 2500 w. 1 plate. Zeitschr d Ver Deutschr Ing—March 4, 1905. No. 68407 D.

The New Electric Locomotives of the Valtellina Railway (Les Nouvelles Locomotives electriques de la Valtelline). Frederic Koromzay. With full details of the mechanical and electrical construction of the new three-phase locomotives of 62 tons weight. 5000 w. 4 plates. Rev Gen d Chem de Fer—March, 1905. No. 68452 G.

The Valtellina Line and the Electrical Operation of Railroad Main Lines. Theodore Köhn. Translated from the *Organ fuer die Fortschritte des Eisenbahnwesens.* Introductory remarks with a comparison between three-phase and three-phase d.-c. operation for main lines are given in the present number. 2700 w. R R Gaz—Vol. XXXVIII. No. 9. Serial. 1st part. No. 68148.

Two Years' Work on the Valtellina Electric Railway (Chemins de Fer Electriques de la Valteline—Résultats de Deux Ans d'Exploitation). An abstract of the report of the engineers to July, 1904. 1000 w. Génie Civil—Feb. 11, 1905. No. 68412 D.

We supply copies of these articles. See page 319.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architecaural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin American Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b.-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Club Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Engineering Times. *m.* London.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Çivil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Minês. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochcemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.